CHAPTER 6.0

ECOSYSTEM RESTORATION FOR FLOOD PLAIN AND FISHERIES RESOURCES

In addition to flood damage reduction, ecosystem restoration is included as a study purpose. The intent of the restoration component is to reestablish the attributes of a functioning and self-regulating ecosystem, and to restore, to the extent possible, fish and wildlife habitat values downstream in the Lower American River. As mentioned in Section 3.5 "Environmental Restoration Problems and Opportunities," the Lower American River has been significantly modified and is a heavily managed system. There is a strong need to restore the environmental resources along the river as the American River Parkway corridor contains all that remains of the historic flood plain and its associated shallow aquatic, wetlands and riparian habitat. A collaborative process was initiated with the local sponsors to identify potential restoration sites. Four areas on the Lower American River were identified as potential restoration sites: Urrutia, Woodlake, Bushy Lake, and Arden Bar (Plate 6-1). Modernization of the Folsom Dam temperature control shutters to improve fish habitat in the Lower American River was identified as another opportunity for ecosystem restoration.

6.1 Flood Plain Restoration

6.1.1 Flood Plain Plan Formulation Process

The plan formulation process for the ecosystem restoration study purpose consists of these basic tasks:

- Establish specific objectives to address the problems and opportunities on the four sites for restoration on the Lower American River.
- Define constraints and criteria for formulating measures and alternatives.
- Develop ecosystem restoration measures including costs and benefits (qualitative and quantitative).
- Develop ecosystem plans from single or combined measures.
- Evaluate and compare alternatives and eliminate alternatives that do not meet the planning objectives and criteria.
- Identify an implementable National Environmental Restoration (NER) Plan for the Lower American River.

6.1.2 Flood Plain Planning Goals and Objectives

Planning goals and objectives were developed to address the identified ecosystem problems and opportunities in the study area. The ecosystem restoration objective is to restore degraded flood plain habitat within the Lower American River

6.1.3 Flood Plain Goals

The following goals guided the formulation of restoration objectives and measures for the four sites:

- Restore diverse native plant communities
- Restore native wildlife habitat
- Establish connectivity between proposed and existing habitats
- Reestablish hydrologic interaction between the flood plain and the river channel
- Reduce potential for fish stranding on the flood plain
- Restore shaded riverine aquatic fish habitat along the streambank

6.1.4 Flood Plain Planning Constraints and Criteria

Overall Constraints

- Proposed ecosystem restoration plans should be consistent with the River Corridor Management Plan (RCMP) and the American River Parkway Plan.

- Proposed ecosystem restoration plans should incorporate a self-sustaining design and require minimal long-term maintenance.

- Minimize effects on existing high-quality vegetation with special emphasis on preserving elderberry shrubs.

- Minimize effects on existing and planned future recreation facilities in the American River Parkway. If changes are needed, relocation of facilities should be part of the restoration plan.

- Minimize effects on existing utility, gas, sewer, cable, and telephone infrastructure and access roads.

- Avoid effects to the existing flood control system including preservation of the flood capacity of the remnant flood plain.

- Minimize effects on or avoid known or potential cultural resources.

- Ensure consistency with applicable laws, regulations, and executive orders including NEPA, the Fish and Wildlife Coordination Act, the Clean Air Act, the Clean Water Act and the Endangered Species Act.

Potential Ecosystem Restoration Sites

Ecosystem restoration sites were selected using the following criteria to evaluate restoration opportunities in the Lower American River:

- Underutilized open space
- Potential willingness of landowners
- Minimal potential to affect existing infrastructure and recreation
- Maximizing use of existing habitat and environmental resources
- Maximizing use of existing studies and available data
- Community support as expressed through the Lower American River Task Force

Based on this evaluation, the following four sites were identified as having a significant potential for achieving ecosystem restoration goals and objectives:

The Urrutia site consists of 251 acres located between RM1 and RM2 on the north bank of the Lower American River (Plates 6-2 and 6-3). The site currently supports a privately owned aggregate surface mining operation that is nearing completion of all mining activities. The site has been severely degraded as a result of past upstream land uses and the present extraction of sand and gravel. A reclamation plan that includes an appropriate end land use is required under State law. Reclaimed land under the State Mining and Reclamation Act (SMARA) is usually designated for permanent open space or agricultural use and this site would most likely be designated as open space because of the requirement for consistency with the American River Parkway Plan. The reclamation plan would also have provisions for a limited amount of onsite grading to establish appropriate gradients. This requirement combined with the site's existing degraded condition within the river's flood plain provides both problems and opportunities for restoration.

The Woodlake site adjoins the upstream end of the Urrutia site and spans the north bank between RM2 and RM4 (Plates 6-4 and 6-5). The site consists of a 283-acre expanse of open space on the river's edge located directly across the river from a highly urbanized central business district and downtown area of the city of Sacramento. The site lies fallow after recent cultivation as hay cropland. Yellow star-thistle, a nonnative invasive weed, has infested the eastern edge of the site and is expected to expand its' range, thereby reducing the capability for native trees, shrubs, and grasses to establish on the site's river terrace. Because nonnative species are expected to continue taking advantage of the absence of hydrological influences and disturbed soils, this site is an attractive candidate for ecosystem restoration within the Lower American River.

The Bushy Lake site consists of 347 acres just upstream of the Woodlake site, between RM4 and RM 5.5 on the north bank of the river (Plates 6-6 and 6-7). Bushy Lake covers about 12 acres of the site's central area. Two urban creeks, Chicken and Strong Ranch Sloughs,

convey urban stormwater runoff to the site's northern boundary, into Bushy Lake and then across the site to discharge into the river.

The Arden Bar site consists of 280 acres located on the north bank of the river, between RM 12 and RM 13 (Plates 6-8 and 6-9). The site currently supports a 45-acre developed active-use park and a 33-acre training facility used by the County Sheriff's Department. The site includes a 34-acre stocked fishing pond that was created by past onsite mining activities and a trail system.

Constraints

Woodlake

- Elevation of the current flood plain is 31 feet above the 20-year flood event; this will restrict or limit the amount of riparian habitat restoration that can be achieved without significant excavation.
- Existing utility easements restrict the height of vegetation in the easement.
- Known and potential cultural resources would need to be integrated into restoration planning and design.

Urrutia

- The private property owner may not be a willing seller.
- Existing utility easements restrict the height of vegetation in the easement.
- Known and potential cultural resources would need to be integrated into restoration planning and design.

Bushy Lake

- Overflow parking for Cal Expo needs to be maintained.
- Disturbance of existing high-quality habitats, especially VELB habitat, must be avoided to the greatest extent possible while achieving the restoration goals and objectives.
- Existing utility easements restrict the height of vegetation in the easement.
- Vehicular access must be maintained to utility and the radio towers.

Arden Bar

- The existing Sheriff's training facility would need to be relocated.

- Vehicular access to existing on-site telephone poles must be maintained.

- Existing moderate- to high-quality native vegetation, especially VELB habitat, should be avoided to the greatest extent possible while achieving the restoration goals and objectives.

Criteria

The ecosystem restoration alternatives were evaluated based on the following four planning criteria: (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability. As the planning process continues, these criteria will be applied to each of the alternatives.

- **Effectiveness:** The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. An effective plan is responsive to the wants and needs of people and makes a significant contribution to the solution of some problem. Alternative plans with a high net increase in HEP values were advanced.

- **Efficiency:** The extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment. Efficiency measures not only evaluate dollar costs, but also evaluate whether other resources are used efficiently in the construction and implementation of a plan; this is represented as "cost-effectiveness." Only cost-effective alternative plans were considered in the array of best buy plans and ultimate selection of the NED Plan.

- **Acceptability:** The workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies. The two primary components of acceptability include implementability, including technological, environmental, economic, and social feasibility, and satisfaction. Alternative plans that were readily implementable and satisfactory to the Corps, Bureau, and local sponsors considered in the final analysis and selection of the NER Plan.

- **Completeness:** The extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. Alternative plans that were thoroughly evaluated by the CE/ICA analyses and presented a solution to the identified problem were considered in the final analysis and selection of the NER Plan.

Benefit Evaluation

HEP Evaluation. The Habitat Evaluation Procedures (HEP) was developed by the Service as an approach to a non-monetary evaluation procedure for use in project planning. HEP is a methodology that rates the quantity and quality of habitat in order to quantify the effects of changes made by land and water development projects. It is also a tool to document baseline information on habitats as a measurement for future habitat modification. The HEP method

provides information for two types of wildlife comparisons: (1) the relative value of different areas, and (2) the relative value of the same area at some future time. In HEP, the quantity part of the formula is any measure of area (e.g., acres, hectares, square miles, or sections) appropriately sized for the study. The quality measurement of the formula is expressed in the form of an index that varies from 0 to 1 and measures how suitable the habitat is for the indicator species when compared to optimum habitat. In a HEP evaluation, an indicator species is selected based on a predicted increase or decrease in the habitat which the species is known to rely upon for survival. The product of the quantitative and qualitative measures in the formula is expressed as a Habitat Unit (HU). (U.S. Fish and Wildlife Service 1980). For ecosystem restoration plan formulation, HUs are converted to Average Annual Habitat Units (AAHUs).

Flood Plain Restoration Measures

Measures are direct actions taken to achieve the restoration goals and objectives. The following measures were developed to meet multiple objectives.

Measure 1: Control Nonnative Invasive Plant Species Using Herbicide and Mechanical (Cutting, Mowing, Manual Extraction) Methods

Description. Nonnative invasive plant species thrive on sites where the soil and hydrological conditions have been altered through climatic and human-induced disturbances. Their presence prevents native plant communities from becoming reestablished, disrupts the food web of native wildlife species, and reduces biodiversity. Restoration of native plant species has been identified as a goal of the RCMP, CALFED, and Lower American River Task Force.

This measure of controlling nonnative invasive plant species can be done through a combination of mowing or cutting and the application of herbicide. Mowing should be done before the plants release seed. Densely infested areas (80-100 percent cover) would be delineated and management and control of species limited to areas immediately adjacent to the delineated area. As neither chemicals nor mowing has proven 100 percent effective in eradicating Yellow Star-thistle, maintenance and control is recommended for the life of the project. Other target species where this method would be effective include giant reed, Himalayan blackberry, sweet fennel, black locust, and scarlet wisteria.

Performance Standards. A program would be developed to ensure the success of this measure. The success of a nonnative invasive plant control program can be determined by observing reduced germination of plants in successive years in a treated area. Eighty percent eradication is a minimal, desirable future condition after 5 years of treatment.

Benefits. This measure would aid in the recovery of native plant communities as well as the nonnative wildlife communities. Measures that involve removing nonnative species were not evaluated using the HEP evaluation see “HEP evaluation section.” As mentioned, the restoration of native plant communities has been identified as a goal for the Lower American River Parkway by CALFED, RCMP, and the Lower American River Task Force.

Costs. The first cost is estimated at $1,050 per acre, and the operation and maintenance cost is estimated at $50 per acre per year.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Urrutia	All non-open water areas	100 to 190
Woodlake	All	180 to 280
Bushy Lake	All non-open water areas	125 to 334
Arden Bar	All non-open water areas	85 to 252

Measure 2: Control Nonnative Invasive Plant Species through Burning

Description. As with measure 1, this measure involves controlling nonnative invasive plant species. This measure consists of an annual burning regime to control nonnative invasive plant species. The timing of the burn would be before plants go to seed and before the area has completely dried out to prevent fire escape.

Nonnative invasive plant species thrive on sites where the soil and hydrological conditions have been altered through climatic and human-induced disturbances. Their presence prevents native plant communities from becoming reestablished, disrupts the food web of native wildlife species, and thereby reduces biodiversity.

Performance Standards. The success of a nonnative invasive plant control program would be determined by observing reduced germination of plants in successive years in a treated area. Eighty-percent eradication is the minimal desirable future condition after 5 years of treatment.

Benefits. This measure would aid in the recovery of native plant communities, prevent nonnative plant communities from becoming reestablished, support the food web for native wildlife species, and increase biodiversity.

Costs. The first cost of this measure is estimated at $50 per acre, and the operation, , and maintenance cost is estimated at $50 per acre.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Urrutia	Higher flood plain areas with ruderal vegetation	10 to 50
Woodlake	Higher flood plain areas with ruderal vegetation	10 to 130
Bushy Lake	Higher flood plain areas with ruderal vegetation	10 to 30

Measure 3: Remove Nonnative Invasive Plant Species through Excavation of the Seed Bank

Description. This measure involves eradicating nonnative species by excavating the top 6- to 12-inches of soil and removing the fill from the site. This method is particularly useful in eradicating yellow star-thistle. The excavated material could be used to fill open waters and pits as the seeds for most of these species, especially yellow star-thistle, won't germinate under water. Another option, if the soil were suitable, would be to store it offsite and use it for levee construction material. Even with implementation of long-term herbicide and burning management programs, star-thistle seeds tend to persist in the topsoil layers. Other target species for this method would be sweet fennel, giant reed, and pampas grass.

Performance Standards. The success of a nonnative invasive plant control program would be determined by observing reduced germination of plants in successive years in a treated area. Eighty-percent eradication is a minimal, desirable future condition after 5 years of treatment.

Benefits. This measure would aid in the recovery of native plant communities. This measure is very effective in removing the nonnative invasives because seeds are removed. Once established, native grasslands would out compete nonnative grasses and forbs.

Costs. The first cost of this measure is $12,500 per acre; no operation and maintenance, or construction costs are associated with this measure.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Urrutia	Higher flood plain and other infested areas	100
Woodlake	Higher flood plain and other infested areas	130
Bushy Lake	Higher flood plain and other infested areas	110
Arden Bar	Higher flood plain and other infested areas	85

Measure 4: Plant Seasonal Wetland Plant Species

Description. This measure addresses the historical loss of seasonal wetlands in the Lower American River flood plain. Very little seasonal wetlands of any quality remain along the Lower American River. This measure involves planting plugs of rushes *(Juncus* spp.*)* and tules *(Scirpus acutus)* at a spacing distance of 10 feet off center. Species would be planted in clusters so that the hydrology of the site would carry seed from the plugs to unplanted areas. No irrigation is recommended for seasonal wetland areas; however, the site should be maintained for 5 years by keeping it weed free and replacing dead plants as necessary.

Performance Standards. Initially planted species should have an 80-100 percent survival rate over the first 3 years. Unplanted areas should begin to show evidence of recruitment of

native wetland plant community species. At the end of 5 years, the wetland would be expected to support 100 percent coverage of native wetland species.

Benefits. This measure would increase the amount of seasonal wetland habitat available for use by native wildlife for nesting and forage. Seasonal wetlands are very scarce in the Lower American River, and implementation of this wetlands measure would increase this scarce resource.

Costs. The first cost of this measure is estimated at $7,000 per acre, and the operation, and maintenance cost is $1,500 per acre per year.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Woodlake	West	2 to 15

Measure 5: Grade the Flood Plain Terrace to Create Appropriate Hydrology to Support Seasonal Wetland Species

Description. Precise grades for the appropriate hydrology on each restoration site should be determined before excavation and planting. Excavated soils need to be removed from individual sites for disposal, stockpiled for later use as levee construction material, or used for restoration purposes at other sites in the Lower American River corridor.

Performance Standards. Initially, planted species should have an 80-100 percent survival rate over the first 3 years. Unplanted areas should begin to show evidence of recruitment of native wetland plant species. At the end of 5 years, the wetland should have 100 percent coverage of native wetland species.

Benefits. This measure would increase the amount of seasonal wetland habitat available for use by native wildlife for nesting and forage. Other benefits include flood plain values of restoring hydrologic connectivity and allowing for natural regeneration of native plant communities.

Costs. The first cost is estimated at $33,000 per acre. The operation and maintenance cost is estimated at $1,500 per acre per year.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Woodlake	West	2 to 15

Measure 6: Plant Riparian Forest Species

Description. Due to the altered hydrology of the Lower American River flood plain and competition from nonnative invasive species, riparian forest species are not regenerating. Riparian forests are a valuable resource in the Lower American River. They are used for cover, perching, and nesting for wildlife.

This measure would involve planting various riparian forest species. The following species with their corresponding size at time of planting are recommended for areas designated to be planted as riparian forest:

Common and Scientific Names	Size
Fremont cottonwood *(Populus fremontii)*	1 gallon
Sycamore *(Platanus racemosa)*	1 gallon
Oregon ash *(Fraxinus latifolia)*	1 gallon
Box elder *(Acer negundo)*	1 gallon
White alder *(Alnus rhombifolia)*	1 gallon
Red willow *(Salix laevigata)*	24-inch cuttings
Yellow willow *(Salix lasiondra)*	24-inch cuttings
Sandbar willow (*Salix hindsiana)*	24-inch cuttings
Goodding's willow *(Salix gooddingii)*	24-inch cuttings
California blackberry *(Rubus ursinus)*	1 gallon

Tree species would be planted at 30 feet on-center. Plastic shelters are recommended for all tree species. Irrigate rooted material for 1 year using Dri-water, slow-release polymer gel cartridges or other similar method. Maintain planted area for 5 years by keeping weed-free, replacing dead plants, and replacing Dri-water cartridges and tree shelters, as necessary.

Performance Standards. Some mortality can be expected from deer browse and beaver damage. While it is not possible to predict mortality from wildlife, the success of the riparian forest becoming self-sustaining is dependent on maintaining survival rates above 80 percent.

Benefits. The size of riparian forest areas would be enlarged. This would provide better cover, shelter, and nesting habitat for migratory songbirds and other native wildlife. The net AAHU gain per acre of riparian forest would range from 0.20 to 0.34 depending on specific site conditions.

Costs. The first cost of this measure is estimated at $8,000 per acre, and the operation and maintenance cost is 2,500 per acre per year.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Bushy Lake	Edges of Bushy Lake	2 to 4
Arden Bar	Island in pond	1
Woodlake	Adjacent to depressional wetland	6 to 10

Measure 7: Grade the Flood Plain Terrace to Establish Hydrology Needed to Support Riparian Forest Species

Description. Each site requires specific grading to lower the land surface elevation needed to establish the hydrology that will support riparian forest species. Excavated material would be removed from the site for disposal, stockpiled for levee construction material, or used for restoration purposes at other sites in the Lower American River corridor.

Performance Standards. Some mortality of riparian forest species would be expected from deer browse and beaver damage. While it is not possible to predict mortality from wildlife, the success of the riparian forest becoming self-sustaining is dependent on maintaining survival rates above 80 percent.

Benefits. The size of riparian forest areas would be enlarged providing better cover, shelter, and nesting habitat for migratory songbirds and other native wildlife. The net AAHU gain per acre of riparian forest would range from 0.29 to 1.19, depending on specific site conditions.

Costs. The first cost of this measure is $34,000 per acre. The operation and maintenance cost is $2,500 per acre per year.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Urrutia	Adjacent to Bannon Slough/flood plain	25 to 65
Woodlake	Southwest and near cross channel	4 to 16
Bushy Lake	Northwest and edges of Bushy Lake	20 to 35
Arden Bar	Along proposed high-flow channel and fish pond	5 to 31

Measure 8: Plant Riparian Oak Woodland Species

Description. Much of the Lower American River's existing oak woodland lies in small, fragmented remnant patches. Larger, connected expanses of oak woodland would provide better wildlife habitat. This measure restores riparian oak woodland species by planting.

The following species would be planted 30 feet on-center. Tree species would be protected with plastic shelters during the first 2-3 years of the establishment period.

Common and Scientific Names	Size
Valley oak (*Quercus lobata*)	50% acorns/50% 1 gallon
Interior live oak (*Quercus wislizenii*)	50% acorns/50% 1 gallon
Blue oak (*Quercus kelloggi*)	50% acorns/50% 1 gallon
Black walnut (*Juglans hindsii*)	1 gallon
Coyote bush (*Baccharis pilularis*)	1 gallon
Elderberry (*Sambucus mexicana*)	1 gallon

This measure includes irrigating for 2 years using Dri-water slow-release polymer gel cartridges or other similar method. It also includes maintenance for 5 years by keeping weed-free, replacing dead plants, replacing Dri-water cartridges and tree shelters, as necessary.

Performance Standards. Sustaining planted oaks would rely heavily on supplemental irrigation for the first several years. The density of the planting factors includes a loss of 10-15 percent of oak species. A minimum of 80 percent survival of planted oak species after 10 years is recommended.

Benefits. Benefits of restoring the oak woodland areas include providing better cover, shelter, and nesting habitat for migratory songbirds and native wildlife. The net AAHU per acre would be about 0.23 AAHUs. In addition, other benefits include flood plain values of restoring hydrologic connectivity and allowing for natural regeneration of vegetation.

Costs. The first cost of this measure is $15,500 per acre and the operation and maintenance costs are $3,000 per acre for the first year, and $2,000 per acre per year thereafter. The O&M interval would extend for 5 years during the first 10 years and once every 5 years thereafter. The establishment period is estimated at 10 years for shrubs and 50 years for full-functioning value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Urrutia	East	5 to 11
Woodlake	South and north	4 to 12
Bushy Lake	East of Bushy Lake	2 to 3

Measure 9: Plant Oak Savanna Species

Description. Extensive areas of oak savanna habitat have been lost in the Central Valley region as land has been converted for development and agriculture. Restoring large, unfragmented areas of oak savanna would benefit the native wildlife that rely on habitat provided by this plant community.

This measure involves planting oak savanna species. The same species proposed for conversion to oak woodland are also recommended for oak savanna. The spacing, however, should be 150 feet for tree species and 50 feet for shrub species, or three shrub species for every oak or walnut tree planting, on average. The planting pattern would take the form of clusters of trees and shrubs with significant open area between the plantings to retain the character of a savanna. The remaining area would be seeded with a native grass mix. All tree species should be protected with plastic shelters. Irrigate for 2 years using Dri-water slow-release polymer gel cartridges, or other similar method, and maintain for 5 years by keeping weed-free, replacing dead plants, replacing Dri-water cartridges, and tree shelters, as necessary.

Performance Standards. Sustaining planted oaks would rely heavily on supplemental irrigation for the first several years. The density of the planting factors includes a loss of 10-15 percent of oak species. A minimum of 80 percent survival of planted oak species after 10 years is recommended.

Benefits. The size of oak savanna areas would be enlarged providing better cover, shelter, and nesting habitat for migratory songbirds and native wildlife. The net AAHU gain per acre would be 0.21 to 0.26 AAHU per acre.

Costs. The first cost is $14,300 per acre and the operation; maintenance and cost would be $2,000 per acre for first year and $1,500 per acre per year for 5 years during the first 10 years; once every 5 years thereafter.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Woodlake	Northeast and east	8 to 19
Bushy Lake	South	30 to 90
Arden Bar	Southwest, along maintenance road, river bend	1.5 to 25

Measure 10: Seed Grassland

Description. Grasslands of significant size have been in decline due to land conversion to agriculture, development, and conversion to nonnative invasive species, such as yellow star-thistle. Before this measure would be implemented, a measure to remove nonnative invasive species would be applied (see measures 1-3). This measure would involve seeding grassland. The flood plain would be disced before drilling or broadcasting seed. A native grass mix appropriate for flood plain ecosystems such as California brome, blue wildrye, meadow barley,

Baltic, Nodding needlegrass, California broom, California buckwheat, and tomcat clover would be used. No irrigation is recommended, but grasslands should be maintained as weed free for 5 years using spot spraying of herbicides and manual removal of nonnative invasive species as necessary.

Performance Standards. Newly seeded grassland is susceptible to invasion by nonnative invasive species, such as yellow star-thistle. Aggressive eradication of nonnative species would improve the success of establishing native grassland. Target performance of the new grassland should be 90-100 percent coverage by native grasses.

Benefits. Large, connected expanses of grassland are vital habitat for many native wildlife species and provide excellent foraging habitat for raptor species. The net AAHU gain per acre is 0.15 AAHU per acre.

Costs. The first cost of this project would be $3,000 per acre. The operation and maintenance cost is estimated at $2,000 per acre per year. The establishment period is 15 years for full-functioning value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Urrutia	East	4 to 10
Woodlake	Interior	60 to 95
Bushy Lake	Southwest	10 to 40

Measure 11: Provide Down, Large Woody Material to Construct Brush Piles

Description. Due to the operation of Folsom Dam and the abandonment of the flood plain by the main American River channel, very little recruitment of woody material makes its way onto the flood plain. Woody material is valuable to native wildlife as it is used for shelter, cover, and nesting. Brush piles are utilized by wildlife as both shelter and nesting habitat. This measure would involve collecting downed, large woody material from the site and placing in loose piles around the site in scattered locations. The loose piles of material would have sufficient internal space for resident small mammals to use.

Performance Standards. The brush piles should be monitored annually to determine if they are being used by wildlife.

Benefits. Brush piles are utilized by wildlife as both shelter and nesting habitat. This measure cannot be quantified using the HEP program. Material from removed nonnative invasive tree species could be used for piles thereby reducing the need for disposal off-site.

Costs. The first cost of the measure is $500 per acre. The operation and maintenance cost is estimated at $250 per acre per year.

Areas of Potential Applicability

Site	Areas in Site	Acreage
All	Higher flood plain areas	

Measure 12: Manage Grassland as Hay Crop for Raptor Forage

Measure 12 was dropped from further consideration because it was determined to be a management measure, rather than an ecosystem restoration measure.

Measure 13: Modify Hydrology and Construct Side-Channels off the Main American River Channel and Plant Shallow Aquatic, Seasonal Wetlands, and Riparian Forest Species

Description. To provide suitable habitat for both Sacramento splittail (Federally listed species) and anadromous fish species, this measure proposes excavating a side channel into the flood plain. The intent of this channel is to provide habitat for splittail, salmon, and steelhead by establishing woody riparian vegetation in the flood plain and providing a connection to the river at the downstream end. Excavated material would need to be removed from the site for disposal, stockpiled for levee construction material, or used for restoration purposes at other sites within the Lower American River Corridor. The resulting side-channel should be planted with seasonal wetland and riparian forest species as outlined in measures 4 and 6, respectively.

Performance Standards. The side channels would be monitored annually for use by fish. Bank stability would also be monitored to ensure no sedimentation of the shallow aquatic area is occurring from adjacent banks.

Benefits. This measure addresses specific needs of the endangered Sacramento splittail and salmon and steelhead. This measure would assist in the recovery and return of these species to the American River system. The net AAHUs per acre for this measure is 1.87 to 1.98 AAHUs. In addition to habitat restoration benefits, this measure would also increase localized flood capacity of the channel.

Costs. The first cost is estimated at $74,500 per acre and the operation and maintenance cost is estimated at $2,500 per acre per year. The establishment period is 5 years and 50 years for full-functioning habitat value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Urrutia	South	25 to 30
Woodlake	Southwest	30 to 34
Bushy Lake	Southeast	0 to 5.5

Measure 14: Construct a High-Flow Bypass Channel

Description. This measure involves excavating a natural channel near the active river channel to provide a high-flow bypass. On-site cobble should be used to create the streambed. Banks of the channel should be planted with riparian scrub species such as willow. Excavated material would need to be removed from the site for disposal, stockpiled for levee construction material, or used for restoration purposes at other sites within the Lower American River. A control structure would be required at the inlet to the channel to ensure that only high flows go through the channel. The outlet should be at a grade one foot below the existing toe of the bank and graded to provide a small backwater area off of the main river channel.

Performance Standards. The side channels should be monitored annually for use by fish for stability of the banks to ensure no sedimentation of the shallow aquatic area is occurring from adjacent banks.

Benefits. The channel would provide backwater, or lentic habitats beneficial to native anadromous fish species including splittail and Chinook salmon and steelhead. The net AAHUs/acre is estimated at 0.45. Other benefits of the high flow bypass channel include reduced hydraulic pressure on steep banks susceptible to erosion.

Costs. The first cost is estimated at $71,500 per acre. The operation and maintenance cost is estimated at $2,500 per acre per year.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Arden Bar	Riverside of fish pond	7

Measure 15: Terrace Steep, Degraded Riverbanks and Plant with Riparian Forest Species

Description. As the main channel of the American River has incised, its adjacent banks have become steep and unable to support riparian vegetation. Wide bands of riparian vegetation immediately adjacent to the main channel are critical areas for both flood plain and aquatic wildlife species.

This measure would involve grading existing, steep banks to 2:1 and 3:1 slopes on average with one minimum 10- to 20-foot wide bench. Additionally, an upper bench of the same size can be incorporated into the design. The measure should be designed to preserve existing mature vegetation where possible. Excavated material would be removed from the site for disposal, stockpiled for levee construction material, or used for restoration purposes at other sites within the Lower American River.

Performance Standards. The side channels should be monitored annually for use by fish. Bank stability should also be monitored to ensure no sedimentation of the shallow aquatic area is occurring from adjacent banks.

Benefits. Creating benches in the bank and planting with riparian forest species would improve the quality of near river habitat. The net AAHU gain per acre is estimated at 1.88 to 2.06. This measure would also increase the hydrological interaction between the main channel and the flood plain.

Costs. The first cost is estimated at $130,000 per acre and the operation and maintenance cost is estimated at 2,500 per acre per year. The establishment period is 5 years and 50 years for full-functioning value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Urrutia	Mining pit banks and adjacent to river	2.5 to 25
Bushy Lake	Southeast	4 to 10

Measure 16: Restore Connectivity between the River Corridor and Flood Plain Terrace by Lowering Berms

Description. Artificial berms along the river's edge would be excavated to appropriate elevations to achieve more frequent inundation of adjacent seasonal wetlands. Excavated material would need to be removed from the site for disposal, stockpiled for levee construction, or used for restoration purposes at other sites in the Lower American River corridor.

Performance Standards. Presence of water in the wetlands during a 1.5-year flow.

Benefits. The artificial berms block moderate flows from inundating areas that would function as seasonal wetlands. Reintroducing flows to these wetlands would increase the diversity of plant and wildlife communities. This measure would result in an increase of the scarce seasonal wetland habitats. Additionally, this measure would increase hydrological interaction between the main channel and the flood plain. The net gain in AAHUs per acre is estimated at 0.49 to 1.22.

Costs. The first cost of this measure is estimated to be $61,500 per acre. The operation and maintenance cost is estimated at $2,000 per acre per year. The establishment period is 5 years and 50 years for full-functioning value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Woodlake	Southwest	1 to 2

Measure 17: Construct Low-Elevation Bank Benches in Interior Open Waters and Plant with Emergent Wetland Species

Description. The banks of both Arden Pond and Urrutia Pit are either devoid of vegetation or colonized by nonnative invasive plant species that are effectively reducing biodiversity and wildlife habitat on these sites. Benches with emergent vegetation would provide a transition between the open water area and the riparian scrub and forest habitat area. This measure would involve planting plugs of emergent wetland species at 15-feet on centers. The planting pattern should take the form of cluster planting so that the hydrology of the site would assist in carrying seeds from the plugs to unplanted areas. The recommended species for planting are cattails *(Typha latifolia)* and tules (*Scirpus acutus).* No irrigation is recommended. The site should be maintained as weed free for 5 years.

Performance Standards. Presence of water in the wetlands during a 1.5 year flow.

Benefits. Emergent wetlands provide excellent waterfowl and migratory bird nesting habitat and shelter. The benches would provide a more gentle transition between the open water and the bank slope and assist with bank stabilization. The net AAHU gain per acre ranges from 0.26 to 0.33.

Costs. The first cost of this measure is $20,500 per acre. The operation and maintenance cost is $2,000 per acre.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Urrutia	Edge of Urrutia pond	2 to 7
Arden Bar	Around fish pond	0.5 to 1.5

Measure 18. Create Natural Stream Channel from Chicken Ranch and Strong Ranch Slough to Bushy Lake and Two Outlet Stream Channels from Bushy Lake to the American River, and Plant with Riparian and Wetland Vegetation.

Description. A natural site stream channel would be excavated/designed to convey water from Chicken Ranch and Strong Ranch Sloughs toward Bushy Lake. The design would incorporate the planning goal of avoiding VELB habitat. Two channels would be excavated from the “fingers” of Bushy Lake to carry water toward the Lower American River. Excavated material could be reused onsite to fill in portions of Bushy Lake that were excavated at the time of the preliminary golf course development on the flood plain (in the 1970s). The banks of the

channels would be planted primarily with wetland vegetation to assist with the uptake of contaminants present in the runoff. Some riparian forest species would be planted to increase wildlife habitat adjacent to the channels. The precise width-to-depth ratio of the channels would be determined by analyzing the total hydrology available to the flood plain. To avoid infestation of the newly created channels by nonnative invasive species, the areas would need to be planted immediately and maintained until the ground vegetation has filled in or through the life of the project.

Performance Standards. It is known that increasing residence time of contaminated water across a surface allows for the soils to filter the water and provide adjacent vegetation increased time to uptake contaminants. This particular measure does not intend to quantify the amount of treatment that would be provided by the wetland, which would normally be required under a regulatory or legislative mandate. The channels would be designed so that the available water would be sufficient to support the new wetland and riparian forest vegetation.

Benefits. The primary beneficiaries of this measure would be fish species, insects, and microorganisms in the Lower American River. These species are a key link in the food web of the corridor, thereby providing benefit for avian and terrestrial species. The wetland and riparian vegetation would provide benefit to bird species by creating nesting habitat.

Because clean water is a common goal of many local, state, and federal agencies for both wildlife and public health reasons, this measure would assist in meeting these goals.

Costs. The first cost of this measure is $33,000 per acre. The operation and maintenance cost is $1,500 per acre. The establishment period is 5 years and 50 years for full-functioning value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Bushy Lake	From and into Bushy Lake	6–10

Measure 19. Improve Water Quality Flowing into American River from Chicken and Strong Ranch Sloughs by Diverting Water Flows above 2 cfs through a Treatment Wetland Complex and into Bushy Lake

Description. This measure calls for diverting water from Chicken and Strong Ranch Sloughs into a constructed wetland and channel system that would convey the diverted water by gravity into Bushy Lake. A lift pump would be installed to access the detention basin at the mouth of Chicken and Strong Ranch Slough. The pump would discharge water onto the floodplain west of the detention basin at a point high enough to create the gradient required to ensure gravity flow through the wetlands to Bushy Lake. In order to bypass existing utility towers and underground cable lines, the initial 800 feet of the diversion would be by pipe with an outlet leading into the constructed wetland system. The wetland system would consist of three separate wetlands to maximize treatment of the water from the sloughs. Excavation of the flood plain terrace to create the wetlands and connecting channels, and planting of appropriate

emergent and wetland species would be the critical elements of wetland creation. The treated water would then be discharged into Bushy Lake at the east bank of the lake. A long-term maintenance plan would be required for a system of this type.

Performance Standards. Further studies are needed to evaluate effects of this measure on water quality in Bushy Lake and the effectiveness of the wetland treatment. Depending on the quality of the diverted water and the effectiveness of the wetland treatment complex, it is possible that Bushy Lake's water quality could be harmed. Therefore, this measure was dropped from further consideration and specific performance standards were not developed.

Benefits. The benefit of this measure would be improved water quality of water entering into the Lower American River and reduced reliance on groundwater pumping to maintain Bushy Lake.

Costs. Specific costs for this measure were not developed after it was dropped from consideration as a restoration measure.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Bushy Lake	Between detention basin and Bushy Lake	10 to 40

Measure 20. Improve the Flow of Water from Sump Pump No. 152 Eastward to Bushy Lake by Removing Metal Fence and Dredging the Channel Bottom to Reestablish a Low-Flow Channel

Description. This measure involves restoring the existing channel from Sump Pump No. 152 to Bushy Lake. To reestablish a low-flow channel, a channel would need to be dredged and obstacles such as the existing metal fence and the debris and vegetation that has accumulated on the west side of the fence would be removed. The second component is to recreate a meandering low-flow channel with positive drainage towards Bushy Lake. The dredged material could be used to recreate flood plains in the channel or removed from the site.

Performance Standard. Positive drainage from the sump pump outlet to Bushy Lake.

Benefits. The benefits of this measure would include increased flow to Bushy Lake, as well as conversion of existing vegetation in and around the lake. By adding more water to Bushy Lake during the summer months when it needs it most, this measure could potentially raise the surface water elevation of the lake which would help suppress duckweed growth in the lake and cocklebur growth in the "fingers."

Costs. The first cost of this measure is $13,500. The operation and maintenance cost is $3,000. The establishment period is 2 years and 10 years for full-functioning value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Bushy Lake	Channel at toe of levee	1 to 3

Measure 21. Fill and Plant with Native Riparian Oak Woodland Species

Description. This measure involves filling in open water to restore habitat suitable for oak woodland and then planting riparian oak woodland species. The elevation of the flood plain terrace would be raised by depositing a minimum of 4 feet of fill material. The following tree species would be planted 30 feet on centers and protected with plastic shelters:

Common and Scientific Names	Size
Valley oak (*Quercus lobata*)	50% acorns/50% 1 gallon
Interior live oak (*Quercus wislizenii*)	50% acorns/50% 1 gallon
Blue oak (*Quercus kelloggi*)	50% acorns/50% 1 gallon
Black walnut (*Juglans hindsii*)	1 gallon
Coyote bush (*Baccharis pilularis*)	1 gallon
Elderberry (*Sambucus mexicana*)	1 gallon

Newly planted trees would require irrigation for 2 years using Dri-water slow-release polymer gel cartridges, or a similar method, and maintenance for 5 years by keeping weed-free, replacing dead plants, replacing Dri-water cartridges and tree shelters as necessary.

Performance Standard. Planted oaks will rely heavily on supplemental irrigation for the first several years. The density of the planting factors in a loss of 10-15 percent of oak species. A minimum of 80 percent survival of planted oak species after 10 years is recommended.

Benefits. Much of the existing oak woodland lies in small, fragmented remnant patches. Re-creating larger, connected expanses of oak woodland would provide better wildlife habitat that more closely resembles the habitat that existed before construction of Folsom Dam. Implementation of this measure would enlarge the size of oak woodland areas thereby providing better cover, shelter, and nesting habitat for migratory songbirds and native wildlife.

Costs. The first cost is estimated at $54,000 per acre. The operation and maintenance cost is estimated at $3,000 per acre in the first year and $2,000 per acre thereafter. The establishment period is 10 years and 50 years for full-functioning value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Arden Bar	Along maintenance road	2 to 3.5

Measure 22. Plant Banks of Proposed High-Flow Bypass Channel with Willow Species

Description. Plant 24-inch willow cuttings and larger in cobble banks of the bypass channel. No irrigation would be required. This measure would only be done in conjunction with measure 14.

Performance Standard. The willow cuttings should have a survivability rate of 80 percent after five years.

Benefits. This measure would increase bank stability of the proposed high-flow bypass channel while increasing its habitat value. Once the willows reach maturity they would provide shelter and nesting habitat.

Costs. The first cost of this measure $2,500 per acre, and the operation and maintenance cost is estimated at $1,500 per acre. The establishment period is 5 years and 50 years for full-functioning value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Arden Bar	Edges of proposed high-flow bypass channel	0 to 4.5

Measure 23. Create Shallow Aquatic Habitat at the Outlet of the Proposed High-Flow Bypass Channel to Create Permanent Lentic Habitat for Native Fish Species

Description. This measure would be constructed in conjunction with measure 14. The area would be graded to 1 foot below the low-water elevation to provide permanent backwater.

Performance Standard. The shallow aquatic habitat should be monitored annually for use by fish. Bank stability should be monitored to ensure no sedimentation of the shallow aquatic area is occurring.

Benefit. Anadromous fish need slow waters located off the main channel for resting during their migration upstream. Many of these side-channels and shallow aquatic areas along the Lower American River have been depleted as a result of changes in the river channel created from hydraulic mining and the construction of upstream dams. This measure addresses specific needs of anadromous fish. This measure could assist in the recovery and return of these fish to the American River system.

Cost. The first cost is $67,500 per acre, and the operation and maintenance cost is $1,500 per acre. The establishment period is 5 years and 50 years for full-functioning value.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Arden Bar	Outlet of proposed high-flow bypass channel	0.5 to 0.75

Measure 24. Remove Levee from around Sheriff's Training Facility and Reuse or Dispose of Material

Description of Actions. Excavate the material creating the levee surrounding the Sheriff's Training Facility and dispose of at an appropriate facility. Material could be reused onsite to reduce the size of the pond and to meet the needs of measure 21.

Performance Standard. Removal of the levee and grading to achieve a constant surface elevation.

Benefits. The levee is a non-conforming use within the parkway. The levee acts as a barrier to movement of large wildlife within the parkway. This measure will also assist in restoring hydrological processes by allowing occasional high flows to pass through this area.

Costs. The first cost of this measure is estimated at $1,250,000 or $40,300 per acre. There is no operation and maintenance cost.

Areas of Potential Applicability

Site	Areas in Site	Acreage
Arden Bar	Around Sheriff's Training Facility	

Measure 25. Install Pump and Delivery System to Divert Flows above 2 cfs from Chicken and Strong Ranch Sloughs to the Bushy Lake (Cal Expo) Flood Plain

Description. This measure should be considered only in conjunction with measure 13 for the Bushy Lake site. A lift pump would be installed on the levee to divert flows above 2 cfs from Chicken and Strong Ranch Sloughs into a constructed side channel with riparian forest, seasonal wetland, and shallow aquatic habitat. The concept is to design the wetland in the side channel to allow as much filtration as possible of the diverted water to provide water quality benefits to the Lower American River.

Performance Standard. The proper operation of the pump delivery system to the side channel should be monitored monthly to ensure it is pumping and delivering an appropriate amount of water from the sloughs.

Benefits. The primary benefit of this measure is an increase in the quality of the water within the Lower American River. This measure could assist local, State, and Federal agencies in meeting clean water goals intended to protect public health and fish.

Costs. The first cost of this measure is estimated at $143,750 to $178,250. The operation and maintenance cost is estimated at $6,500 to $8,200 per year. The range in costs captures the rising cost of electricity.

6.1.5 Measure 26. Purchase Land

Description. This measure consists of the purchasing of land necessary for implementation of all of the ecosystem restoration measures. Real estate requirements and costs are incorporated into the individual measures formulated for each restoration site.

Costs. The following real estate acquisition costs were determined for each restoration site:

Arden Bar	$112,000
Bushy Lake	$138,800
Urrutia	$910,880
Woodlake	$113,200

6.1.6 Screening of Flood plain Ecosystem Restoration Measures Evaluation of Ecosystem Restoration

Initial Screening of the Measures

The measures, annual cost, first cost, and benefits considered at each site are summarized in Tables 6-1 through 6-4. As shown in these tables, one or more scale, or sizes, of each measure were chosen for use in the initial screening of measures.

6.1.7 Cost Effectiveness and Incremental Cost Effective Analyses of Flood plain Restoration Measures

The average annual equivalent costs and benefits (average annual habitat units) from Tables 6-1 through 6-4 were used to conduct cost effectiveness and incremental cost analyses (CE/ICA). IWR-Plan Decision Support software version 3.0 was used for the analysis. This initial analysis was completed on a site-by-site basis. IWR-PLAN first builds all possible alternative plan combinations based on the potential combinations of measures, whether the measures can be combined with each other, and whether any measures are dependent on each other.

In some flood plain cases, certain measures are dependant on each other. For all four flood plain sites, all measures were dependent on purchasing the land (measure 26) and the eradication of nonnative invasive plant species (measures 1 and 3). For the Woodlake site, to maintain existing good raptor habitat, all other measures were dependent on measure 10 (seed grassland). For the Bushy Lake site, measure 18 (restore emergent wetlands) is dependent on measure 25 (install pump) which is further dependent on measure 7 (grade flood plain terrace).

TABLE 6-1. Initial Screening–Ecosystem Restoration Measures–Urrutia Site

		Cost					Benefits	
Measures	**IWR Symbol**	**First Cost/ Acre**	**Avg O&M Cost**	**Annual Cost/ Acre/Year**	**Acres**	**Annual Cost**	**AAHU Gain/Acre**	**Total AAHUs**
Measure 1. Herbicide application and mechanical eradication of non-native invasive plant species	T	1,050	50	124	10	1,240		No Value (0)
Measure 7. Grade the floodplain terrace to restore appropriate hydrology to support riparian forest species	A	34,000	650	3,030	25	75,750	0.87	21.75
	B	34,000	650	3,030	45	136,350	0.87	39.15
	C	34,000	650	3,030	55	166,650	0.87	47.85
	D	34,000	650	3,030	65	196,950	0.87	56.55
Measure 8. Plant riparian oak woodland species	E	15,500	540	1,625	5	8,125	0.1	0.50
	F	15,500	540	1,625	11	17,875	0.1	1.10
Measure 10. Seed grassland	G	3,000	520	730	4	2,920	0.02	0.08
	H	3,000	520	730	7	5,110	0.02	0.14
	I	3,000	520	730	10	7,300	0.02	0.20
Measure 13. Modify hydrology and construct side-channels off the main American River channel and plant shallow aquatic, seasonal wetland, and riparian forest species	J	74,500	650	5,865	25	146,625	1.93	48.25
	K	74,500	650	5,865	30	175,950	1.93	57.90
Measure 15. Terrace steep, degraded riverbanks and plant with riparian forest species	L	130,000	650	9,750	2.5	24,375	2.06	5.15
	M	130,000	650	9,750	17	165,750	2.06	35.02
	N	130,000	650	9,750	21	204,750	2.06	43.26
	O	130,000	650	9,750	25	243,750	2.06	51.50
Measure 17. Construct low-elevation bank benches in interior open waters and plant with emergent wetland species	P	20,500	520	1,955	2	3,910	0.26	0.52
	Q	20,500	520	1,955	4.5	8,798	0.26	1.17
	R	20,500	520	1,955	7	13,685	0.26	1.82
Measure 26. Purchase land	S	7,000		490	122.8	60,172		No Value
		400		28	128.2	3,590		(0)

TABLE 6-2. Initial Screening–Ecosystem Restoration Measures–Woodlake Site

Measures	IWR Symbol	Cost					Benefits	
		First Cost/ Acre	Avg. O&M Cost	Annual Cost/ Acre/Year	Acres	Annual Cost	AAHU Gain/Acre	Total AAHUs
Measure 1. Herbicide application and mechanical eradication of non-native invasive plant species	T1	1,050	50	124	30	3,720		No Value (0)
Measure 3. Excavate seed bank to remove non-native invasive plant species	T2	12,500	0	875	65	56,875		No Value (0)
Measure 4. Plant seasonal wetland plant species	W	7,000	390	880	2	1,760	0.05	0.10
	X	7,000	390	880	3	2,640	0.05	0.15
	Y	7,000	390	880	13	11,440	0.05	0.65
	Z	7,000	390	880	15	13,200	0.05	0.75
Measure 6. Plant riparian forest species	A	8,000	650	1,210	6	7,260	0.33	1.98
	B	8,000	650	1,210	10	12,100	0.33	3.30
Measure 7. Grade the floodplain terrace to restore appropriate hydrology to support riparian forest species	C	34,000	650	3,030	4	12,120	0.48	1.92
	D	34,000	650	3,030	10	30,300	0.48	4.80
	E	34,000	650	3,030	16	48,480	0.48	7.68
	R	34,000	650	3,030	13	39,390	0.48	6.24
Measure 8. Plant riparian oak woodland species	G	15,500	540	1,625	4	6,500	0.23	0.92
	H	15,500	540	1,625	8	11,375	0.23	1.84
	I	15,500	540	1,625	12	19,500	0.23	2.76
	S	15,500	540	1,625	10	16,250	0.23	2.30
Measure 9. Plant oak savanna species	J	14,300	391	1,392	8	11,136	0.21	1.68
	K	14,300	391	1,392	12	16,704	0.21	2.52
	L	14,300	391	1,392	15	20,880	0.21	3.15
	M	14,300	391	1,392	19	26,448	0.21	3.99
Measure 10. Seed grassland	N	3,000	520	730	60	43,800	0.15	9.00
	O	3,000	520	730	75	54,750	0.15	11.25
	P	3,000	520	730	85	62,050	0.15	12.75
	Q	3,000	520	730	95	69,350	0.15	14.25
Measure 16. Restore connectivity between the river corridor and flood plain terrace by lowering berms	U	61,500	520	4,825	5.5[a]	4,825	0.88	4.84
	V	61,500	520	4,825	8.5[b]	9,650	0.88	7.48
Measure 26. Purchase land	F	400		28	283	7,924		No Value (0)

[a] 1 acre of cost = 5.5 acres of benefit

[b] 2 acres of cost = 8.5 acres of benefit

TABLE 6-3. Initial Screening–Ecosystem Restoration Measures–Bushy Lake Site

Measures	IWR Symbol	Cost					Benefits	
		First Cost/ Acre	Avg. O&M/ Acre	Annual Cost/ Acre/Year	Acres	Total Annual	AAHU Gain/Acre	Total AAHUs
Measure 1. Herbicide application and mechanical removal of non-native invasive plant species	S2	1,050	50	124	20	2,480		No Value (0)
Measure 3. Excavate seed bank to remove non-native invasive plant species	S3	12,500	0	875	20	17,500		No Value (0)
Measure 6. Plant riparian forest species	A	8,000	650	1,210	2	2,420	0.27	0.54
	B	8,000	650	1,210	3.5	4,235	0.27	0.95
Measure 7. Grade the floodplain terrace to restore appropriate hydrology to support riparian forest species	C	34,000	650	3,030	20	60,600	0.58	11.6
	Z	34,000	650	3,030	30	90,900	0.58	17.4
	E	34,000	650	3,030	40	121,200	0.58	23.2
	F	34,000	650	3,030	50	151,500	0.58	29.0
Measure 8. Plant riparian oak woodland species	G	15,500	540	1,625	2	3,250	0.23	0.46
	H	15,500	540	1,625	3	4,875	0.23	0.69
Measure 9. Plant oak savanna species	I	14,300	391	1,392	30	41,760	0.26	7.80
	J	14,300	391	1,392	55	76,560	0.26	14.30
	K	14,300	391	1,392	80	111,360	0.26	20.80
	L	14,300	391	1,392	90	125,280	0.26	23.40
Measure 10. Seed grassland	M	3,000	520	730	10	7,300	0.15	1.50
	N	3,000	520	730	20	14,600	0.15	3.00
	O	3,000	520	730	40	29,200	0.15	6.00
	D	3,000	520	730	30	21,900	0.15	4.5
Measure 13. Modify hydrology and construct side-channels off the main American River channel and plant shallow aquatic, seasonal wetlands, and riparian forest species	P	72,500	650	5,865	4.25	24,926	1.87	7.95
	Q	72,500	650	5,865	5.5	32,258	1.87	10.29
Measure 15. Terrace steep, degraded riverbanks and plant with riparian forest species	R1	130,000	650	9,750	4	39,000	1.88	7.52
	R2	130,000	650	9,750	6	58,500	1.88	11.28
	T	130,000	650	9,750	8	78,000	1.88	15.04
	U	130,000	650	9,750	10	97,500	1.88	18.80
Measure 18. Restore emergent wetlands	V1	33,000	390	2,700	6	16,200	0.35	2.1
	V2	33,000	390	2,700	8	21,600	0.35	2.8
	W	33,000	390	2,700	10	27,000	0.35	3.5
Measure 20. Restore storm water drainage channel from sump pump 152 to Bushy Lake	Y1	13,500	1,020	1,965	1	1,965		No Value (0)
	Y2	13,500	1,020	1,965	3	5,895		
Measure 25. Install pump to improve water quality entering American River	X	178,250		12,775	1	12,775		No Value (0)
Measure 26. Purchase land	S1	400	0	28	347	9,716		No Value (0)

TABLE 6-4. Initial Screening–Ecosystem Restoration Measures–Arden Bar Site

Measures	IWR Symbol	Cost					Benefits	
		First Cost/ Acre	Avg. O&M Cost	Annual Cost/ Acre/Year	Acres	Annual Cost	AAHU Gain/Acre	Total AAHUs
Measure 1. Herbicide application and mechanical eradication of non-native invasive plant species	A	1,050	50	124	110	13,640		
Measure 7. Grade the floodplain terrace to restore appropriate hydrology to support riparian forest species	B	34,000	650	3,030	5	15,150	0.58	2.90
	C	34,000	650	3,030	8	24,240	0.58	4.64
	D	34,000	650	3,030	21	63,630	0.58	12.18
	E	34,000	650	3,030	26	78,780	0.58	15.08
	F	34,000	650	3,030	31	93,930	0.58	17.98
Measure 9. Plant oak savanna species	J	14,300	1,001	1,401	1.5	2,101	0.28	0.42
	K	14,300	1,001	1,401	8	11,208	0.28	2.24
	M	14,300	1,001	1,401	21	29,421	0.28	5.88
	N	14,300	1,001	1,401	25	35,025	0.28	7.00
Measure 14. Construct a high-flow bypass channel	O	71,500	500	5,505	7	38,535	0.45	3.15
Measure 17. Construct low-elevation bank benches in interior open waters and plant with emergent wetland species	P	20,500	520	1,955	0.5	978	0.33	0.17
	Q	20,500	520	1,955	1	1,955	0.33	0.33
	R	20,500	520	1,955	1.5	2,933	0.33	0.50
Measure 21. Fill and plant with native riparian oak woodland species	S	54,000	540	4,320	2	8,640	0.3	0.60
	T	54,000	540	4,320	3.5	15,120	0.3	1.05
Measure 22. Plant banks of proposed high-flow bypass channel with willow species	U	2,500	390	565	4.5	2,543	0.55	2.48
Measure 23. Create shallow aquatic habitat at the outlet of the proposed high-flow bypass channel to create permanent lentic habitat for native fish species	V	67,500	390	5,115	0.5	2,558	0.77	0.39
	W	67,500	390	5,115	0.75	3,836	0.77	0.58
Measure 24. Remove levee from around Sheriff's Training Facility and reuse or dispose of material	X	77,000	0	5,390	9	48,510		No Value (0)
Measure 26. Purchase land	Y	400	0	28	280	7,840		No Value (0)

These measures would work in combination to effectively create a functioning wetland complex that connects Chicken and Strong Ranch Sloughs to Bushy Lake and then to the American River.

Some measures are not combinable. For example if measure 1 is applied at a site, then measure 2 would not be applied at that same site, since these measures accomplish the same purpose of eradicating nonnative invasive plant species. The primary constraint in combining the flood plain measures at all four sites was the size of the land. Since, each site has a certain acreage, not all measures could be applied at their maximum scales. A list of combinable measures was developed and this data was imputed into the software program.

For the analysis of flood plain restoration measures, the software program ran all possible combinations. Cost effectiveness and incremental cost analyses were performed by the IWR-Plan model. This analysis was used to limit the number of ecosystem restoration plan alternatives. CE/ICA analysis identifies the least-cost solutions for each level of output. The three criteria used for identifying non-cost effective plans or combinations include: (1) the same level of output could be produced by another plan at less cost; (2) a larger output level could be produced at the same cost; or (3) a larger output level could be produced at least cost. The cost effective combinations ranged from 65 at Woodlake to 165 at Urrutia.

Incremental cost is the change in cost that results from a decision. Incremental cost analysis compares the incremental costs for each additional unit of output. This is not the average cost per output. The first step in developing the best buy plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the no action plan is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the lowest incremental cost per unit for the next level of output is calculated. The intent of the incremental analysis is to identify large increases in cost relative to output.

The flood plain best buy plan alternatives range from one plan at Arden Bar to 8 plans at Woodlake. The Best Buy alternatives for each site are summarized in Tables 6-5 through 6-8, and are shown in Plates 6-10 through 6-13.

Flood Plain Measures Not Evaluated Using Incremental Analysis

Some flood plain measures were not evaluated using the incremental analysis program, because they could not be evaluated using the HEP evaluation procedure. Therefore, these measures did not have any intrinsic HEP value or quantifiable benefits. However, the purchase of land measure (measure 26) and the eradication of nonnative invasive plant species measures (measures 1 and 3) were included in the incremental analysis by making all other measures dependent upon these two measures and assigning costs only input to the IWR-Plan program. The following measures were eliminated from further consideration during the initial screening of measures:

Measure 2. Control of nonnative invasive plant species through burning. This measure was not assigned a HEP value and implementation would be very difficult because of local and regional air quality control permitting requirements.

Measure 11. Provide down, large woody material to construct brush piles. This measure was not assigned a HEP value based on the Habitat Suitability Index (HSI) model that was used to evaluate restoration measures.

Measure 12. Manage grassland as hay crop for raptor forage. This measure was screened out during the evaluation of measures because it was determined to be a land management measure rather than a site restoration measure.

Measure 19. Divert water from Chicken and Strong Ranch Sloughs into Bushy Lake. This measure was screened out because of its potential to harm the water quality of Bushy Lake.

6.2 Fisheries Restoration

6.2.1 Fisheries Plan Formulation Process

Under Corps guidelines, the purpose of ecosystem restoration is to restore significant ecosystem function, structure, and dynamic processes that have been degraded. The intent of restoration is to reestablish the attributes of a, functioning, and self-regulating system. The formulation of this plan focuses on this stated purpose and intent. The project team evaluated several different measures for reconfiguring current structures or implementing the construction of new structures to facilitate optimum management of water temperature in the Lower American River. These measures are outlined in detail in Appendix A, Attachment 5, and a recommended fisheries ecosystem restoration measure was advanced for this analysis.

6.2.2 Fisheries Goals and Objectives

Planning goals and objectives were developed to address the identified problems and opportunities for improving fisheries and aquatic habitat in the Lower American River.

6.2.3 Fisheries Goals

The FISH Working Group, 1 of the 4 working groups of the Lower American River Task Force, commissioned the preparation of a report, the Baseline Report, outlining baseline conditions within the Lower American River with respect to aquatic habitat. The Baseline Report provided the basis for prioritizing opportunities for restoration of aquatic habitat in the Lower American River. The Baseline Report established that flow and temperature improvements have the greatest potential for restoration with respect to the fish of primary management concern. As a result, the most immediate opportunities that exist for fish habitat improvement involve dam operations and management actions. Manipulating the timing, temperature, and rate of flow released from Folsom and Nimbus Dams is likely to produce the most immediate and effective results for fish restoration (Surface Water Resources 2001a).

An adequate flow and water temperature regime is essential to create favorable conditions for Lower American River salmonids. Streamflow patterns are important in maintaining geomorphology of watersheds such as meander belts and stream channel configuration, as well as riparian and flood plain vegetation along stream banks. Streamflow influences the well-being of valley wetlands, riparian communities, and the habitat of fish and other aquatic organisms. Streamflow also is essential for the well-being of native resident fish, including anadromous salmonids. Sufficient flows are necessary for anadromous salmonid adult migration, spawning, egg incubation, and juvenile rearing and emigration especially because these functions must now occur in the lowermost 23 miles of the American River below Nimbus Dam. In some cases, flows exceeding natural, unimpaired river flows below Nimbus Dam are recommended because anadromous salmonids must conduct these functions in the nontraditional habitats of the lower river instead of the upstream reaches above Folsom Dam (Surface Water Resources 2001a).

Of all limiting factors and potential corrective actions, maintaining suitable water temperatures and instream flows will be more beneficial for salmonid production in the Lower American River than all other actions combined. Flow standards are currently under development by the Water Forum. Therefore, building on the baseline conditions and prioritization summarized in the Baseline Report prepared for the FISH Working Group, the following goals have been established for the management and restoration of water temperature in the Lower American River below Nimbus Dam:

- **Goal 1:** Reduce water temperature in the Lower American River during critical stages in the life cycles of Sacramento River fall/late fall-run Chinook salmon and Central Valley steelhead so as to increase the number of these fish spawning naturally in the river.

- **Goal 2:** To the greatest extent possible, reach those temperatures recommended by the CDFG for Central Valley steelhead and Sacramento River fall/late fall–run Chinook salmon (i.e., 56°F between October 1 and June 30 and between 56 and 60°F for July 1–September 30).

- **Goal 3:** Significantly increase the Central Valley steelhead and Sacramento River fall/late fall–run Chinook salmon natural production fish populations in the Lower American River. This goal is in line with the policy of the Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988 to double the natural production of salmon and steelhead by the end of the last century.

6.2.4 Fisheries Objectives

Based on the aforementioned goals, objectives were developed to complement and provide focus to these goals. Some objectives are applicable to more than one goal. All are in-stream temperature related.

TABLE 6-5. Initial Alternatives (Best Buy Plans For Urrutia)

Measures in the Plan	Increm. Annual Cost/Unit Output	Increm Output (AAHU)	Increm. Cost	Total Annual Cost	Total AAHUs	Average Cost/ AAHUs	Total First Cost
Grade/plant riparian forest- 55 acres; Create side channels-30 acres; Purchase Land; Herbicide/Mechanical removal of non-native invasive plant species-10 acres	$3,815	105.75	$403,402	$403,402	105.75	$3,814	$5,026,380
Grade/plant riparian species-55 acres; Create side channels -30 acres; Terrace Steep Banks -21 acres; Purchase Land; Herbicide/Mechanical removal of non-native invasive plant species-10 acres	$4,733	43.26	$204,750	$608,152	149.01	$4,733	$7,756,380
Grade/plant riparian species-55 acres; Create side channels -30 acres; Terrace Steep Banks -21 acres; Construct low level bank benches- 2 acres; Purchase Land; Herbicide/Mechanical removal of non-native invasive plant species-10 acres	$7,519	0.52	$3,910	$612,062	149.53	$4,093	$7,797,380
Grade/plant riparian species-55 acres; Create side channels -30 acres; Terrace Steep Banks -21 acres; Construct low level bank benches- 4.5 acres; Purchase Land; Herbicide/Mechanical removal of non-native invasive plant species-10 acres	$7,520	0.65	$4,888	$616,950	150.18	$4,108	$7,848,630
Grade/plant riparian species-55 acres; Plant Riparian Oak Woodland-11 acres; Create side channels -30 acres; Terrace Steep Banks -21 acres; Construct low level bank benches- 4.5 acres; Purchase Land; Herbicide/Mechanical removal of non-native invasive plant species-10 acres	$16,102	1.1	$17,875	$634,825	151.28	$4,196	$8,019,130
Grade/plant riparian species-55 acres; Plant Riparian Oak Woodland-11 acres; Create side channels -30 acres; Terrace Steep Banks -21 acres; Seed Grassland - 10 acres; Construct low level bank benches- 4.5 acres; Purchase Land; Herbicide/Mechanical removal of non-native invasive plant species-10 acres	$36,500	0.2	$7,300	$642,125	151.48	$4,239	$8,049,130

Best Buy Plans – Urrutia

Incremental Cost ($) vs. Incremental Output (AAHUs)

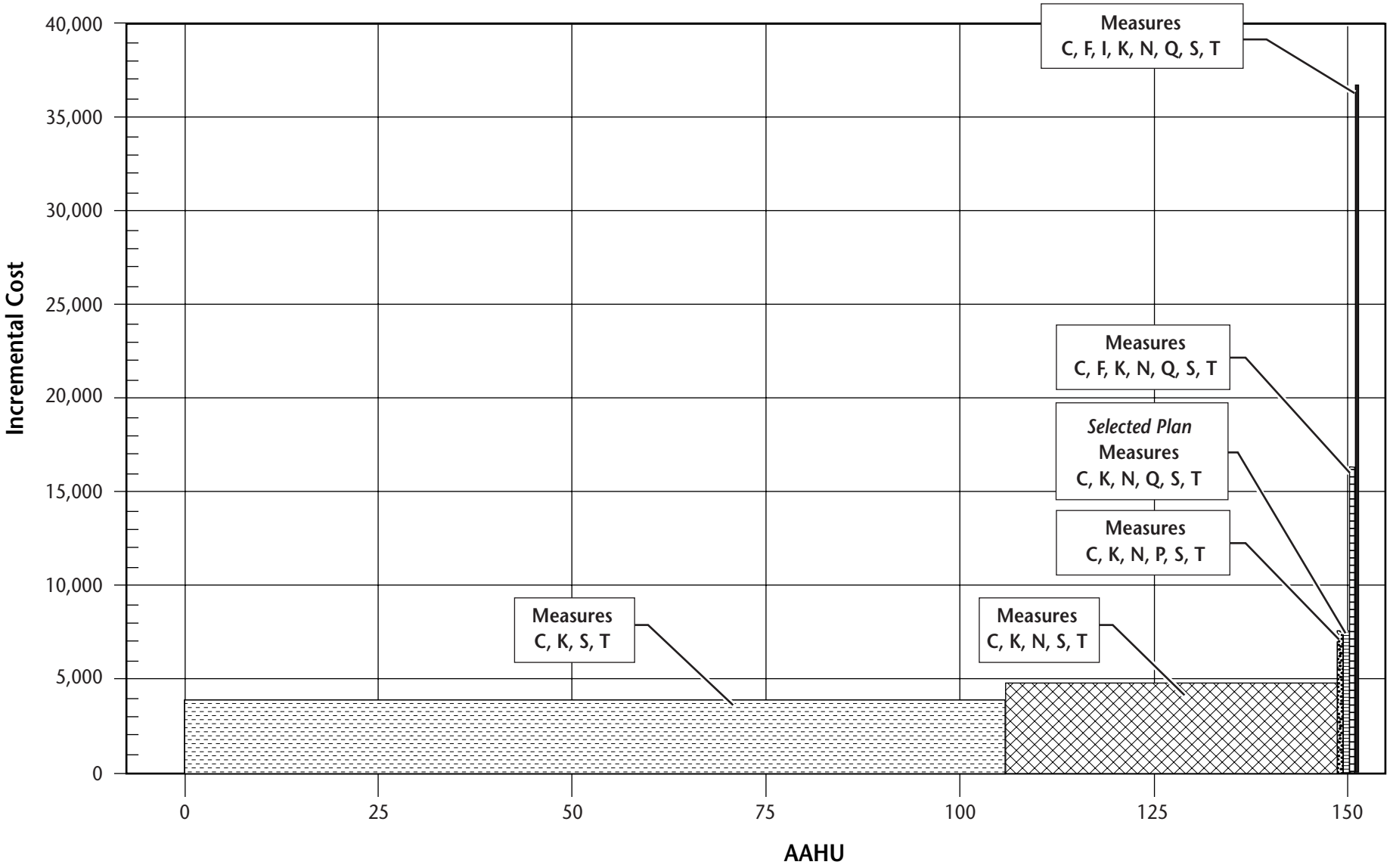


TABLE 6-6. Initial Alternatives (Best Buy Plans For Woodlake)

Measures in the Plan	Increm. Cost/Unit Output	Increm. Output (AAHU's)	Increm. Cost	Tot. Annual Cost	Total AAHU's	Average Cost $/AAHU	First Cost
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-30 acres; Excavate Seed Bank-30 acres; Seed Grassland - 60 acres; Restore Connectivity- 8.5 acres; Plant Riparian Forest-6 acres	$3,920	18.46	$72,354	$72,354	18.46	$3,036	$1,246,700
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-30 acres; Excavate Seed Bank-30 acres; Seed Grassland – 75 acres; Restore Connectivity- 8.5 acres; Plant Riparian Forest-6 acres	$4,867	2.25	$10,950	$83,304	20.71	$4,022	$1,291,700
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-30 acres; Excavate Seed Bank-30 acres; Seed Grassland – 95 acres; Restore Connectivity- 8.5 acres; Plant Riparian Forest-6 acres	$4,867	3.00	$14,600	$97,904	23.71	$4,867	$1,351,700
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-30 acres; Excavate Seed Bank-30 acres; Seed Grassland – 95 acres; Restore Connectivity- 8.5 acres; Plant Riparian Forest-6 acres; Grade/Plant Riparian Forest-10 acres	$6,313	4.80	$30,300	$128,204	28.51	$4,497	$1,691,700
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-30 acres; Excavate Seed Bank-30 acres; Seed Grassland – 95 acres; Restore Connectivity- 8.5 acres; Plant Riparian Forest-6 acres; Grade/Plant Riparian Forest-10 acres; Plant Oak Savanna-8 acres	$6,629	1.68	$11,136	$139,340	30.19	$4,615	$1,806,100
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-30 acres; Excavate Seed Bank-30 acres; Seed Grassland – 95 acres; Restore Connectivity- 8.5 acres; Plant Riparian Forest-6 acres; Grade/Plant Riparian Forest-10 acres; Plant Oak Savanna-8 acres; Plant Oak Woodland-4 acres	$7,065	0.92	$6,500	$145,840	31.11	$4,688	$1,868,100
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-30 acres; Excavate Seed Bank-30 acres; Seed Grassland – 85 acres; Restore Connectivity-5.5 acres; Plant Riparian Forest-10 acres; Grade/Plant Riparian Forest-16 acres; Plant Oak Savanna-12 acres; Plant Oak Woodland-8 acres	$13,420	1.59	$21,338	$167,178	32.70	$5,112	$2,136,625
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-30 acres; Excavate Seed Bank-30 acres; Seed Grassland – 85 acres; Restore Connectivity-5.5 acres; Plant Riparian Forest-10 acres; Grade/Plant Riparian Forest-16 acres; Plant Oak Savanna-12 acres; Plant Oak Woodland-8 acres; Plant Seasonal Wetlands-3 acres	$17,600	0.15	$2,640	$169,818	32.85	$5,169	$2,157,625

Best Buy Plans – Woodlake

Incremental Cost ($) vs. Incremental Output (AAHUs)

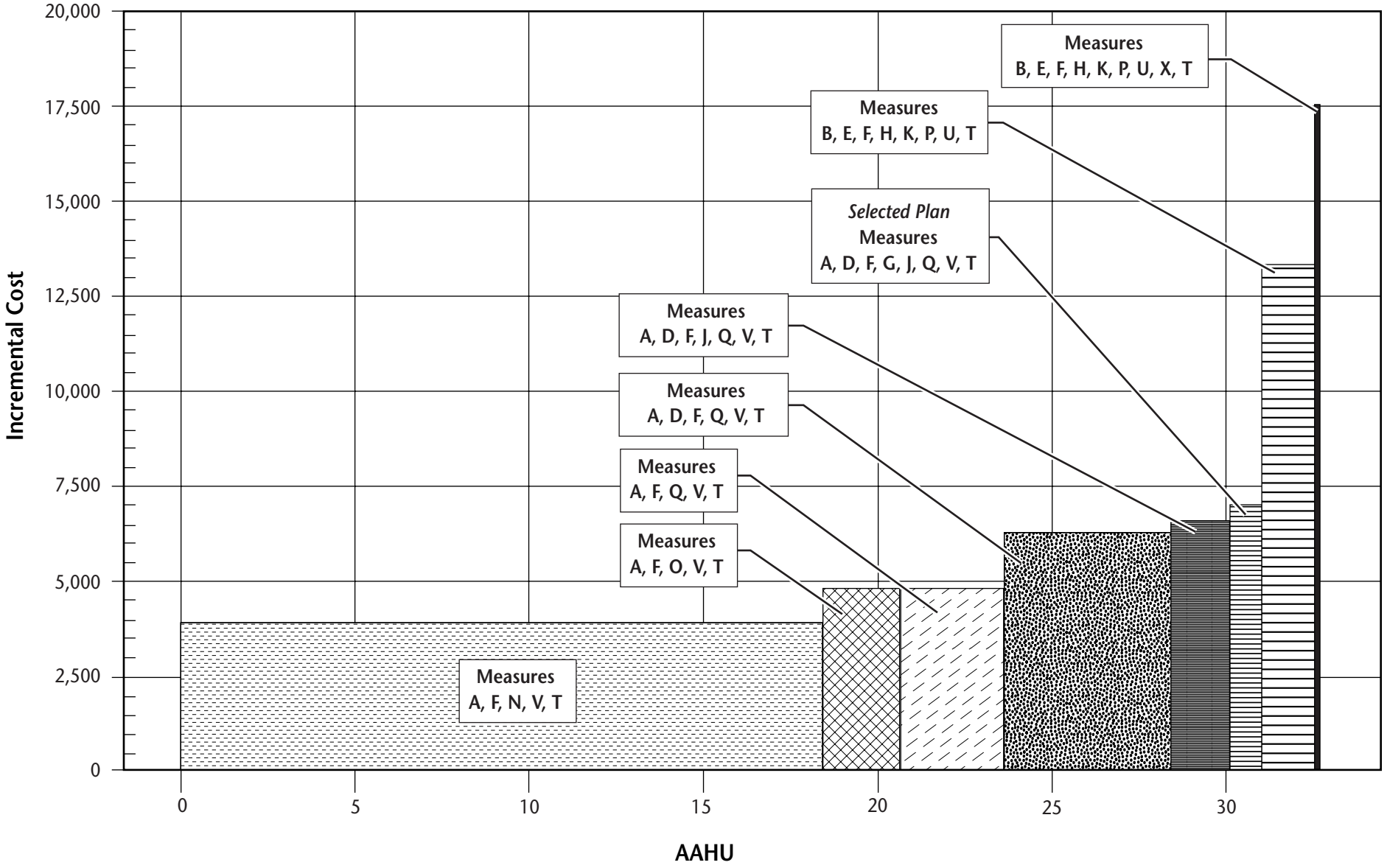


TABLE 6-7. Initial Alternatives (Best Buy Plans For Bushy Lake)

Measures in the Plan	Increm. Cost/Unit Output	Increm. Output (AAHU's)	Increm. Cost $	Tot. Annual Cost	Total AAHU's	Average Cost $/AAHU	Total First Cost
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-20 acres; Excavate Seed Bank -20 acres; Grade/Plant Riparian Forest-40 acres; Construct Side Channels-5.5 acres; Terrace Steep Banks-6 acres; Restore Emergent Wetlands-6 acres; Install Pump and Delivery System	$5,214	46.87	$244,358	$244,358	46.87	$5,214	$3,335,800
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-20 acres; Excavate Seed Bank -20 acres; Grade/Plant Riparian Forest-40 acres; Construct Side Channels-5.5 acres; Terrace Steep Banks-6 acres; Restore Emergent Wetlands-6 acres; Install Pump and Delivery System; Plant Oak Savanna-55 acres	$5,350	14.30	$76,500	$320,858	61.17	$5,245	$4,122,300
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-20 acres; Excavate Seed Bank -20 acres; Grade/Plant Riparian Forest-50 acres; Construct Side Channels-4.25 acres; Terrace Steep Banks-6 acres; Restore Emergent Wetlands-6 acres; Install Pump and Delivery System; Plant Oak Savanna-55 acres	$6,638	3.46	$22,968	$343,826	64.63	$5,319	$4,369,175
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-20 acres; Excavate Seed Bank -20 acres; Grade/Plant Riparian Forest-50 acres; Construct Side Channels-4.25 acres; Terrace Steep Banks-6 acres; Restore Emergent Wetlands-6 acres; Install Pump and Delivery System; Plant Oak Savanna-55 acres; Plant Oak Woodland-2 acres	$7,000	0.46	$3,220	$347,046	65.09	$5,332	$4,400,175
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-20 acres; Excavate Seed Bank -20 acres; Grade/Plant Riparian Forest-50 acres; Construct Side Channels-4.25 acres; Terrace Steep Banks-6 acres; Restore Emergent Wetlands-6 acres; Install Pump and Delivery System; Plant Oak Savanna-55 acres; Plant Oak Woodland-3 acres	$7,000	0.23	$1,610	$348,656	65.32	$5,338	$4,415,675
Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-20 acres; Excavate Seed Bank -20 acres; Grade/Plant Riparian Forest-50 acres; Construct Side Channels-4.25 acres; Terrace Steep Banks-6 acres; Restore Emergent Wetlands-8 acres; Install Pump and Delivery System; Plant Oak Savanna-55 acres; Plant Oak Woodland-3 acres	$7,714	0.70	$5,400	$354,056	66.02	$5,363	$4,481,675

Best Buy Plans – Bushy Lake

Incremental Cost ($) vs. Incremental Output (AAHUs)

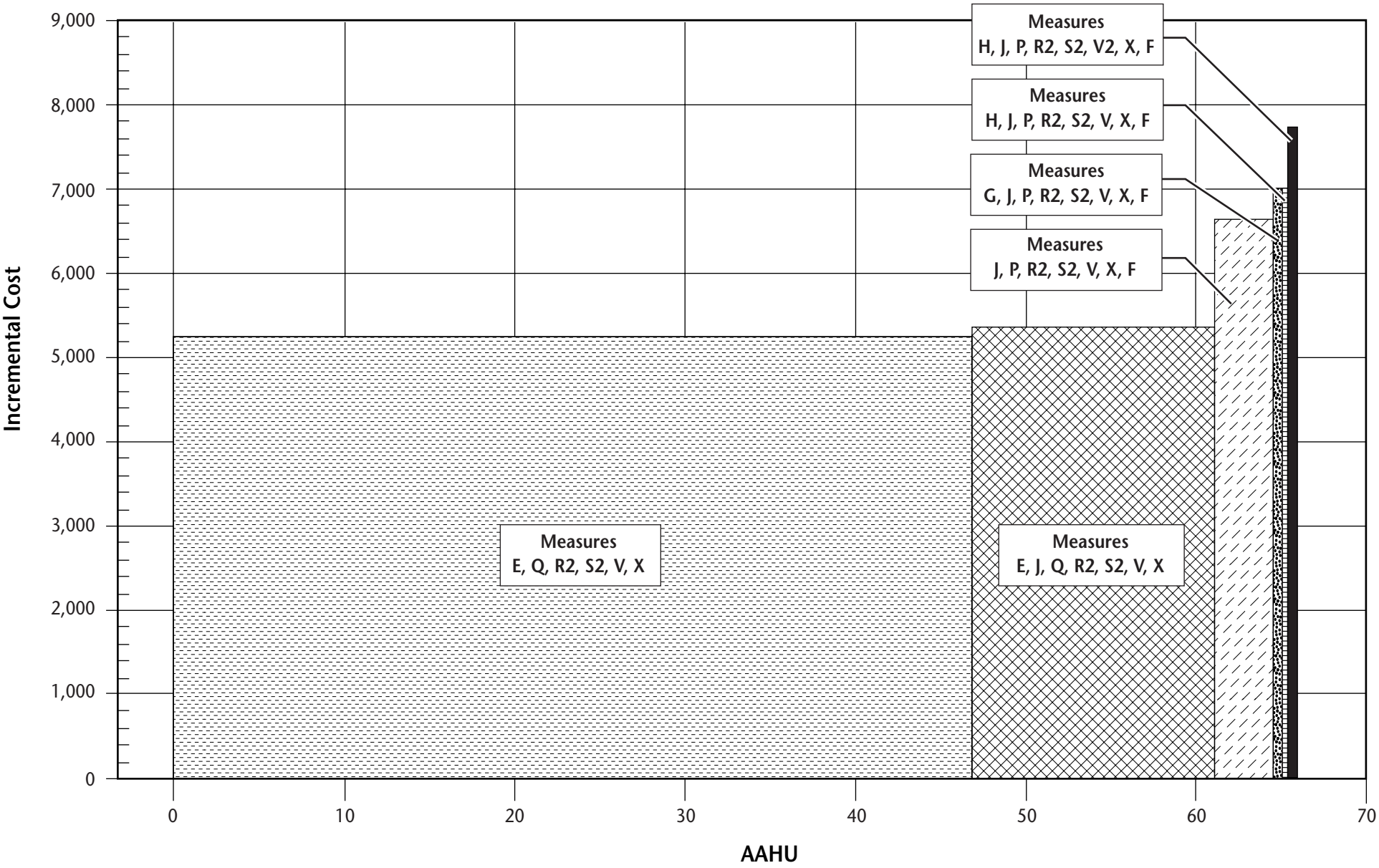
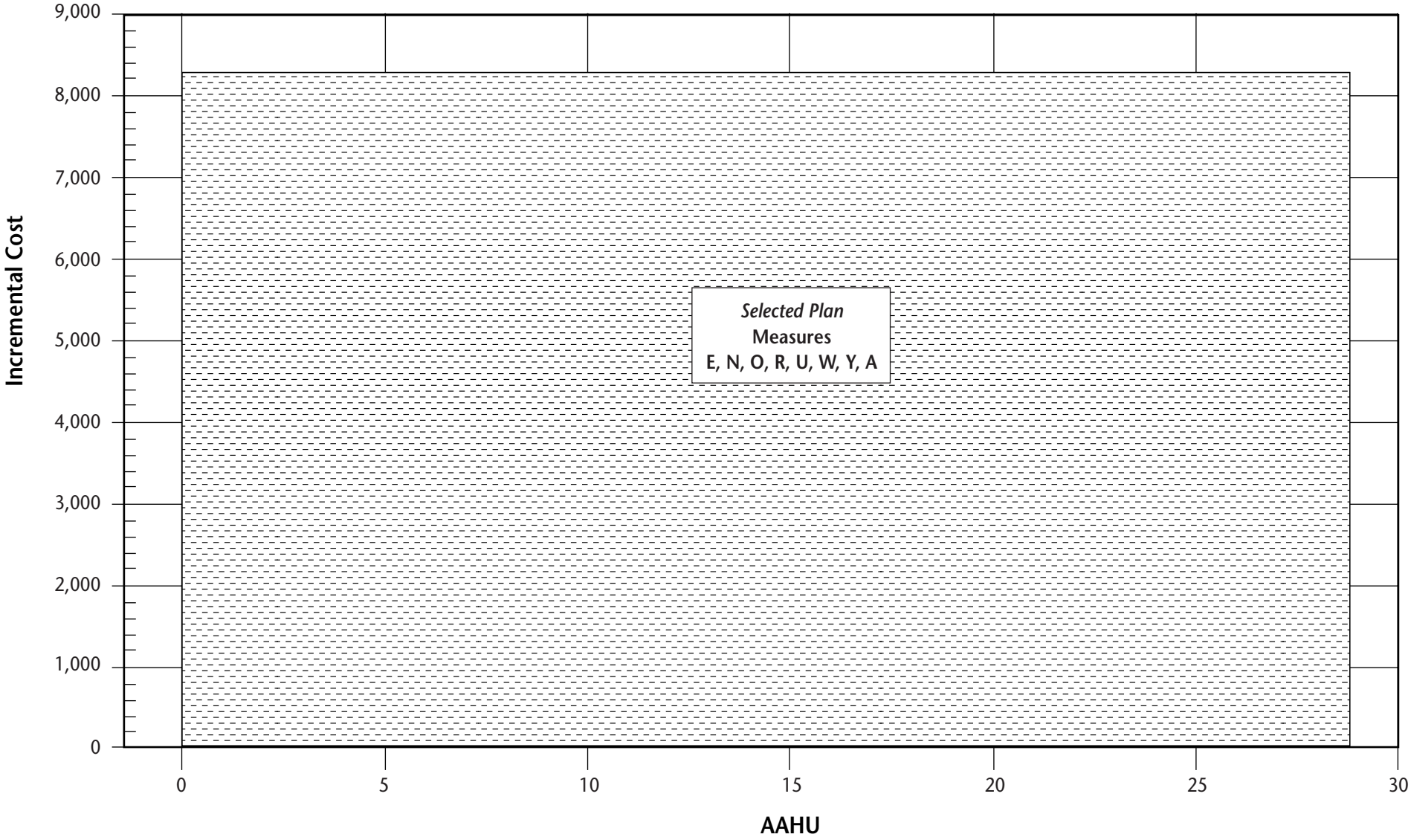


TABLE 6-8. Initial Alternatives (Best Buy Plans For Arden Bar)

Measures in the Plan	Increm. Cost/Unit Output	Increm. Output (AAHU's)	Increm. Cost $	Total Annual Cost	Total AAHU's	Average Cost $/AAHU	Total First Cost
Purchase Land; Eradicate non-native plant species; Grade/Plant Riparian Forest-26 acres; Plant Oak Savanna-25 acres; Construct low level bank benches-1.5 acre; Construct high-flow bypass channel-7 acres; Plant banks of high-flow bypass; Create lentic habitat at high-flow bypass channel outlet.	$8,300	28.79	$238,961	$238,961	28.79	$8,300	$2,860,505

Best Buy Plans – Arden Bar 2

Incremental Cost ($) vs. Incremental Output (AAHUs)



Objective 1: Improve Adult Migration

Elevated temperatures in late summer and early fall in the Lower American River (sometimes extending well into October) often exceed 65ºF. Relatively high water temperatures delay the onset of adult fall-run chinook salmon spawning and impede reproductive success. Exposure of prespawning adult chinook salmon to relatively high water temperatures can result in increased prespawning mortality, reduced gamete production, infertility, and increased embryonic developmental abnormalities.

Objective 2: Increase Spawning Habitat

Chinook salmon spawning is concentrated in several well-documented areas in the river, primarily between RM 14 and 22. During low-flow conditions and high-temperature conditions, the extent of available spawning habitat is further restricted. Adult fall-run chinook salmon generally do not initiate spawning in the Lower American River until water temperatures decrease to approximately 60°F.

Objective 3: Reduce Egg Mortality

Constant exposure of salmonid eggs to temperatures above 56°F will result in some egg mortality, and incubation at constant water temperatures above 63°F is believed to result in complete egg mortality. Temperatures above 56ºF can occur when eggs and alevins are incubating in the Lower American River. This problem is most likely to occur for chinook salmon in October and November.

Objective 4: Improve Rearing Habitat and Juvenile Outmigration

The availability of rearing habitat is directly related to flow; however, physical habitat availability considerations are probably overridden by water temperature concerns during late spring, summer, and early fall. In addition to direct thermal stress, elevated temperatures during rearing and outmigration of the chinook salmon and steelhead can result in multiple indirect effects, including increased risk of predation, decreased growth rates, starvation, and susceptibility to disease, which contribute to reduced juvenile survival. Thermal stress to juvenile steelhead is a particular problem from July through October, when water temperatures at Watt Avenue frequently exceed 65°F.

6.2.5 Fisheries Restoration Planning Constraints and Criteria

Overall Constraints

Consideration was given to several planning constraints during development of the goals, objectives, and measures:

- Proposed restoration activities should be consistent with the RCMP.

- Existing high-quality wildlife habitat, fisheries habitat, and native plant communities should not be disturbed by restoration activities.

- American River Parkway recreation activities should be maintained.

- Existing major utility, gas, sewer, cable, and telephone infrastructure should remain in place with existing access maintained.

- The flood capacity of the floodway should be maintained.

- Proposed restoration activities should be self-sustaining, requiring little long-term maintenance.

- Generation of hydroelectric power at Folsom Dam water supply should be maintained.

- Boating and other recreation on Folsom Reservoir and Lake Natoma should be maintained.

The following section evaluates measures that could be implemented to achieve the aforementioned goal and objectives, while considering the planning criteria and constraints.

Site Specific Constraints

Additional site specific constraints were also addressed including:

- cost
- ease of operation,
- flexibility,
- reliability,
- construction schedule, and
- environmental impacts during construction.

Criteria

The structural and operational temperature reduction techniques were screened to identify a preferred temperature restoration measure. The screening criteria used for this analysis include:

- **Effectiveness:** The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. An effective plan is responsive to the wants and needs of people and makes a significant contribution to the solution of some problem. Measures that make a significant contribution to the planning goals were advanced.

- **Efficiency:** The extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment. Efficiency measures not only evaluate dollar costs, but also evaluate whether other resources are used efficiently in the construction and implementation of a plan; this is represented as "cost-effectiveness." Only cost-effective measures were advanced.

- **Acceptability:** The workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies. The two primary components of acceptability include implementability, including technological, environmental, economic, and social feasibility, and satisfaction. Measures that were readily implementable and satisfactory to the Corps, Bureau, and FISH Work Group were advanced.

- **Completeness:** The extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. Measures that were well thought out and whose implementation actions are accounted for in context of all investments and actions were advanced.

Benefit Evaluation

HEP Evaluation

The HEP process is described in detail above in the Flood plain Restoration section.

Fisheries Restoration Measure

Background

At certain times, high water temperatures are a serious limiting factor affecting the reproduction, growth and survival of anadromous salmonids in the Lower American River. Historically, this is not thought to have been a problem. Before the modern era of dams and development on the American River, adult salmonids returning to the river to spawn were transiently and periodically exposed to warm water temperatures in the Sacramento-San Joaquin Delta, lower Sacramento River, and Lower American River. However, upon their ascent to over 100 miles of upstream historic spawning and rearing reaches above where Folsom Dam is now sited, perennially cooler water temperatures were encountered and water temperatures were likely rarely, if ever, an important population-limiting factor. Moreover, most downstream movements of juvenile salmonids are believed to have historically occurred during spring and early summer, when Lower American River flows were high and cool due to runoff from the melting snowpack in the nearby Sierra Nevada Mountains.

Under present conditions and with existing facilities, including Folsom and Nimbus dams, salmonid life cycles have been artificially restricted to existing conditions in the Lower American River. Releases of coldwater (resulting from seasonal stratification of Folsom reservoir) to the river in the optimal temperature ranges for salmon and steelhead depend on

many variables. However, frequently such coldwater is often either in low supply or completely unavailable for anadromous fishery needs.

The two most common adverse biological impacts are: (1) exposure of pre-spawning adult salmon to elevated water temperatures in the fall; and (2) exposure of juvenile steelhead to elevated water temperatures during the spring through early fall, particularly during hot summer periods with maximum solar radiation. Such impacts do at times, depending on the severity and duration of the elevated water temperatures, become population-limiting factors for Lower American River anadromous salmonids.

Maintenance of optimal water temperatures for salmonids in the Lower American River depends on the ability to deliver coldwater releases to the river from Folsom Dam and hence through Nimbus Dam. This in turn is limited by: (1) the volume of the coldwater pool available behind the dams (mainly behind Folsom Dam); and (2) the ability to physically access this coldwater and deliver it downstream as needed to promote suitable aquatic habitat for downstream fisheries.

Water Temperature Objectives

Currently, reservoir release operations follow an iterative process referred to as the Automated Temperature Selection Procedure (ATSP) in which target water temperatures, as measured in the river flow at Watt Avenue, are achieved by drawing release water from specific reservoir levels. The most preferred (and realistically achievable) Schedule 1 water temperatures at Watt Avenue which would have the lowest impacts to salmonids are: 56°F during May; 56.5°F during June; 65°F during July-September; 57°F during October; and 55°F during November. River water temperatures are not considered to be a problem during the remaining months (December-April) when abundant seasonal coldwater is available for release from the reservoirs.

Under the ATSP process, when the Schedule 1 temperatures cannot be met, a Schedule 2 temperature regime, which is only slightly more detrimental to salmonids, is attempted. When Schedule 2 temperatures cannot be met, the process continues cycling downward through a series of 48 total schedules to the next slightly more detrimental temperature regime for the critical (spring-fall) months. This continues until a schedule of temperature targets, which is considered the least detrimental (to salmonids) regime feasible under existing conditions (i.e., current reservoir storage, available coldwater pool, Delta inflow needs, air temperatures, and other determinants) can be met for the year. In many years, including in 2001, coldwater is either already limited or depleted early in the critical period, thus a temperature target schedule highly detrimental to salmonids must be adopted.

In addition to the ATSP, National Marine Fisheries Service has issued an interim Biological Opinion for Central Valley Project operations that includes an objective to not exceed a mid-day water temperature of 65°F in the Lower American River at Watt Avenue throughout the year. This criterion is for the preservation of juvenile steelhead rearing habitat. Excessive water temperatures are considered to be the most significant stressor affecting juvenile steelhead in the river. Juvenile steelhead remain in the river throughout the year, whereas juvenile salmon

emigrate from the river within at most a few months after hatching. Low over-summer survival of steelhead is believed to be the cause of the apparent low numbers of naturally-spawned steelhead which return annually to the river. Most of the river's returning steelhead are of hatchery origin.

Fisheries Habitat Problems and Excessive Water Temperatures

The detriments of excessive water temperatures to salmonids can be in the form of direct mortality to adults, juveniles, and eggs when temperature thresholds are greatly exceeded and/or exceeded for extended periods. In addition, a number of chronic, sub-lethal and indirect effects of high water temperatures, which are nevertheless sometimes population-limiting factors, are experienced which include the following:

- Causing smaller fry to be produced, which have lower survival due to increased vulnerability to predation, reduced overwinter survival, and alterations of their downstream migration timing;

- Causing poor body condition, which increases susceptibility to predation and diseases;

- Increasing food requirements and thus intra- and inter-specific competition for available feeding stations and food supplies;

- Causing premature seaward migration from the river, which causes fish to be ill-prepared physiologically to survive in a saline environment;

- Delaying the onset of salmon spawning in the fall, causing reduced egg production and fertility, greater egg retention, and increased embryonic abnormalities, in addition to the direct pre-spawning mortality of the returning adults; and

- Crowding spawning salmon into the uppermost Lower American River reaches where water is the coolest, causing spawning nest (redd) superimposition which also reduces productivity.

Evaluation of Water Temperature Measures

Recently, several structural and operational measures have been identified and preliminarily evaluated for their utility to help alleviate Lower American River water temperature problems for salmonids. Two broad approaches examined were: (a) increasing coldwater pool volumes behind the two dams and/or (b) improving access to and delivery of such water to the river (U.S. Bureau of Reclamation 2001). Of the structural and operational measures examined, the one with the most promise and ultimately selected as the preferred plan alternative is a structural measure involving modernization of the water outlet (temperature control) shutters of Folsom Dam. Folsom Dam shutter modernization is being considered an ecosystem restoration measure for evaluation because of its potential to help restore historical water temperature regimes needed to maximize the Lower American River's natural in-river

anadromous salmonid production. As described above, these historical water conditions are no longer available to the river's fisheries.

The operation of and present problems with Folsom Dam's temperature control shutters have recently been described in detail by Surface Water Resources, Inc. (SWRI) (2001a, 2001b), the Bureau (2001), and HDR Engineering (2001).

Existing Shutter Operations Problems

Folsom Dam's temperature control shutters are a series of large, solid metal plates or panels within metal tracks which can be lowered or raised to allow reservoir water to enter the three penstocks leading to the dam's power-generating turbines. After passing the turbines, the water empties into the Lower American River.

Each of the three power penstock intakes on the dam is enclosed in a housing that supports a set of 45 removable 13-foot high shutter panels. Each group of 45 shutters is arranged in 5 vertical columns of 9 panels each. A varying number of shutters can be lifted up to draw water from various elevations within the reservoir, thereby controlling the temperature of water entering the Lower American River.

However, presently, there is no capability to raise each of the 45 shutters individually and independently. Instead, shutters are bolted together such that the nine shutters comprising each vertical column have a 3-2-4 configuration. This means that the top three panels are bolted together and are raised as a unit, followed by the next two panels as a unit, and the last four panels as a unit. This configuration allows for reservoir water to be drawn into the penstocks from four distinct elevation ranges (i.e., with no panel, lowest panels, two lowest panels, or all three panels [shutter groups] in place.)

The present 3-2-4 shutter configuration and operations (for controlling temperatures) have a number of drawbacks and problems which are ultimately detrimental to the river's salmonid fisheries as follows:

- Each shutter change is labor intensive, requiring a three-person crew for completion. Often, because of scheduling conflicts with other duties of the crew, needed temperature changes are either delayed or foregone completely;

- Each shutter change is time-consuming, requiring 8-12 hours, sometimes spread over a 2-day period, which further delays a responsive implementation of needed changes;

- Each shutter change causes traffic delays and stoppage across the Folsom Dam Road, a heavily traveled corridor. As a result, there is often pressure on operators to delay or forego changes.

- Due to the various constraints, usually only about 3-5 shutter modifications can actually be made each critical season, whereas optimal temperature management for salmonid benefits might necessitate some multiple of this number;

- Some amount (as yet unquantified) of coldwater is believed to be lost annually from leakage occurring at or around the existing shutters and their related structural features. This is coldwater that could otherwise be available for fisheries maintenance.

- Each shutter change is at best a rather coarse action, which means that often, much more coldwater must be released to achieve a particular temperature objective than would be necessary with a more efficient, high-operational-flexibility system. Again, this results in wasted coldwater that could otherwise benefit salmonids later in the same critical season. The inefficiency clearly results in some subsequent within-season temperature objectives failing to be met. In addition, the present system results in frequent severe temperature "spikes" both upwards and downwards, which may in and of themselves be a detrimental impact to fish and/or the river's aquatic food base.

Measures Evaluated

As set forth in Appendix A, Attachment 5, a series of temperature reduction measures was evaluated. These measures were identified during a three-day Folsom Dam temperature management conference sponsored by the Bureau in January 2001. Based on this evaluation, reconfiguration and modernization of the dam's temperature shutter system were selected as the most effective measures. Measure 1 calls for modifying the shutter housings to allow each of the top seven shutters to be raised and lowered individually. Because of flow limitations into the penstocks, each of the bottom two shutters would be operated as a single unit. The resulting new shutter configuration would thus be 1-1-1-1-1-1-1-2, or 7(1)-2, compared to the current 3-2-4 configuration. The new configuration would provide the greatest possible operational flexibility using the existing shutters, allowing the reservoir withdrawals to occur at 13-ft intervals. This would create essentially the same operational flexibility as a truly unlimited shutter-positioning scheme.

The 7(1)-2 project could be built for either manual or automated operation. Although the automated system would have considerably higher construction cost, the manual operation was determined to be infeasible because of structural, operational, and institutional constraints (HDR Engineering 2001, Jones & Stokes 2001b).

Measure 2 involves the same kind of shutter housing modifications, except that a less flexible 1-1-2-2-3 configuration would be created. The 1-1-2-2-3 configuration has been proposed as mitigation for the long-term reoperation of Folsom Reservoir and thus constitutes the future without project condition. This configuration would allow for selection of six different release elevations instead of the present four. Operation would continue to be manual. While greater operational flexibility would be achieved, it would be much less flexible than Measure 1.

Salmon Mortality Modeling Results. SWRI (2001a) used a combination of existing Lower American River modeling tools, with appropriate modifications, to derive estimates of the annual mortality to early-life-stage chinook salmon that would occur under various shutter configurations (see SWRI 2001a for detail). The models that SWRI (2001a) used produced outputs suitable only for comparative planning purposes, and not for predicting actual in-river

conditions at specific times and locations. Thus, these salmon mortality data are not definitive absolute values, but merely broad indicators providing "reasonable detection limits" of changes and general ranges that would be expected.

Only salmon mortality results were derived because a similar model of steelhead mortality was not available. However, SWRI's (2001a) modeling analyses were completed in a manner assuming the "best" year around balanced water temperature conditions for both salmon and steelhead. Thus, benefits for salmon often equate with benefits for steelhead. Otherwise, a planning effort (for water temperatures) directed only at the summer needs of juvenile steelhead would often result in severely depleted coldwater reserves needed by fall-spawning adult salmon. Conversely, planning aimed at the water temperature needs of fall salmon would often result in severe impacts to juvenile steelhead during summer.

SWRI's (2001a) salmon mortality data (Table 6-9) were used in concert with other qualitative results and findings they presented to derive an Habitat Suitability Index (HIS) for use here in the HEP application. HSIs for the HEP were derived using the model presented below. SWRI's (2001a) mortality estimates for salmon (Table 6-9) are given for only three "representative" water year-types: "favorable," "moderate," and "adverse" in which the modeled ATSP temperature schedules would generally correspond with favorable, moderate, and adverse temperature regimes for salmonids during the critical spring-fall period. In assigning HSIs using the word model presented below, it was assumed that each of these three year-type classifications used by SWRI (2001a) occurred in roughly one-third of all water years.

TABLE 6-9. Estimated (from Modeling) Annual Early-Life-Stage Salmon Mortality (%) in Relation to Various Water Temperature Shutter Control Configurations and Methods at Folsom Dam, by General Water Year-Type

General Water Year-Type	Shutter Configuration And Operation Mode			
	Existing (Man.) 3-2-4	**Projected (Man.) 1-1-2-2-3**	**Modernized (Man.) 7(1)-2**	**Modernized (Auto.) 7(1)-2**
Favorable	14.3	8.7	5.9	5.2
Moderate	10.1	11.9	6.1	6.6
Adverse (Drought)	16.2	20.0	13.6	9.0

Source: Surface Water Resources, Inc. 2001a.

HEP Results

The aquatic habitat that would be affected by the shutter reconfiguration measures was assumed to be the Lower American River from Nimbus Dam downstream 13 miles to Watt Avenue. Watt Avenue was the reference point for the SWRI (2001a) modeling effort. This reference point was previously selected by the NMFS in its biological opinion on interim operations of the CVP and SWP on federally listed threatened Central Valley spring-run chinook salmon and threatened Central Valley steelhead as part of the Bureau consultation under Section 7 of the Federal Endangered Species Act. First, based on data in SWRI (2001b), it was determined that the mean monthly post-1956 (Folsom and Nimbus Dams completed) flow in the Lower American River for the critical temperature control months of April-November is about 2,600 cfs. Next, based on a systematic sample of 25 river surface-width cross sections measured

from aerial photographs of the river taken at a flow of about 3,000 cfs, it was determined that the average April-November river width in the Nimbus-Watt Avenue reach is about 286 feet. Multiplying the average reach width by its length yields a riverine surface area estimate of 451 acres during the annual critical period. This is the value used in the HEP. The HEP analysis completed for the temperature control shutter alternative indicates that juvenile steelhead would be the primary beneficiaries of temperature improvements, but little is known within the scientific community about habitat preferences of juvenile steelhead within the Lower American River. To be conservative in describing benefits to this species, the HEP used the whole surface area of the river downstream from the dam to Watt Avenue. While acknowledging that juvenile steelhead rearing does extend further downstream, the area used to quantify HEP values is considered a reasonable estimate of habitat area.

Measure 1, modernization of the shutters into an automatic 7(1)-2 mode would have an associated HSI of 0.7. This index would result in a net gain of habitat value of 1,105.0 AAHUs.

Measure 2, reconfiguration of the shutters as part of the future without-project condition was assigned an HSI of 0.2. This future condition would result in a net gain of habitat value of 315.7 AAHUs and would thus accrue for an average net gain of 0.70 AAHU per acre. These values were subtracted from the net gains produced by Measure 1 so as to reflect in the incremental accomplishments of this measure.

Performance Standard. The proper operation of the modernized shutter system should be monitored monthly to ensure the shutters operate correctly and deliver expected temperature reductions downstream.

Costs and Benefits. The total costs and benefits of the fisheries ecosystem restoration measure are depicted in Table 6-10. The first cost of this measure is estimated at $19,800,000. The operation and maintenance cost is estimated at $215,000 per year. The primary benefit of this measure is a decrease in downstream water temperatures within the Lower American River during critical life stages. This measure provides significantly enhanced management of the cold-water pool in Folsom, and the greatest operational flexibility in all year.

TABLE 6-10. Initial Alternatives (Best Buy Plans for Fisheries Ecosystem Restoration)

		Cost					Benefits [1]	
Measures	**IWR Symbol**	**First Cost**	**O&M Cost**	**Annual Cost/ Acre/ Year**	**Acres**	**Annual Cost**	**AAHU Gain/ Acre**	**Total AAHUs**
Measure 1	A	19,800,000	215,000	3,629	451	1,637,000	2.45	1,105

[1] Benefits reflect gains from future without project condition

TABLE 6-11. Fisheries Ecosystem Restoration Measure

Measure	Increm. Annual Cost/Unit Output	Increm. Output (AAHU)	Increm. Cost	Total Annual Cost	Total AAHUs	Average Cost/ AAHUs	Total First Cost
Measure 1. Sliding shutters with mechanized operation	$3,629	$789.3	$2,864,370	$1,637,000	789.3	2,075	$19.8m

6.3 Selection of the NER Plan

The Water Resources Policies and Authorities for Ecosystem Restoration (EP 1165-2-502) state that the Corps has the responsibility for ecosystem restoration studies and projects within the Civil Works program. This policy also states that projects involving direct modification of an existing project does are not required to demonstrate that the Corps project contributed to environmental degradation. The ecosystem restoration planning for this project was initiated and continues as a collaborative effort in accordance with Corps policy.

The NER Plan (Table 6-12) was formulated based on cost effectiveness and incremental cost analyses (CE/ICA) of the recommended plan alternatives for each restoration site. The IWR-Plan model was used to conduct this analysis and the results are shown in Tables 6-5 through 6-8 and Table 6-11. As shown, best buy plans were determined at each of the flood plain restoration sites based on the point at which incremental cost increase were substantial relative to the output or net gain in AAHUs. The NER Plan includes the fisheries restoration plan alternative developed for the Folsom Dam temperature shutters, and the selected best buy plans for the 4 flood plain restoration sites. Based on review of the CE/ICA results and the analysis of measures for the improvement of fisheries habitat in the Lower American River, the NER Plan includes the measures and combinations measures formulated into alternative plans for individual restoration sites shown in Table 6-12.

TABLE 6-12. National Ecosystem Restoration Plan

Measures in the Plan	Increm. Annual Cost/Unit Output	Increm Output (AAHU)	Increm. Cost	Total Annual Cost	Total AAHUs	Average Cost/ AAHUs	Total First Cost
Urrutia. Grade/plant riparian species-55 acres; Create side channels -30 acres; Terrace Steep Banks -21 acres; Construct low level bank benches- 4.5 acres; Purchase Land; Herbicide/Mechanical removal of non-native invasive plant species-10 acres	$7,520	0.65	$4,888	$616,950	150.18	$4,108	$9,613,987
Woodlake. Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-30 acres; Excavate Seed Bank-30 acres; Seed Grassland – 95 acres; Restore Connectivity- 8.5 acres; Plant Riparian Forest-6 acres; Grade/Plant Riparian Forest-10 acres; Plant Oak Savanna-8 acres; Plant Oak Woodland-4 acres	$7,065	0.92	$6,500	$145,840	31.11	$4,688	$2,431,853
Bushy Lake. Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-20 acres; Excavate Seed Bank -20 acres; Grade/Plant Riparian Forest-50 acres; Construct Side Channels-4.25 acres; Terrace Steep Banks-6 acres; Restore Emergent Wetlands-8 acres; Install Pump and Delivery System; Plant Oak Savanna-55 acres; Plant Oak Woodland-3 acres	$7,714	0.70	$5,400	$354,056	66.02	$5,363	$6,018,139
Arden Bar. Purchase Land; Herbicide/Mechanical Removal of Non-native Invasive Species-110 acres; Excavate Seed Bank-110 acres; Grade/Plant Riparian Forest-26 acres; Plant Oak Savanna-25 acres; Construct low level bank benches-1.5 acre; Construct high-flow bypass channel-7 acres; Plant banks of high-flow bypass-4.5 acres; Create lentic habitat at high-flow bypass channel outlet.	$8,300	28.79	$238,961	$238,961	28.79	$8,300	$2,702,386
Fisheries and Aquatic Restoration in LAR. Sliding shutters with mechanized operation	$3,629	789.30	$2,864,370	$1,637,000	789.30	$2,075	$19,800,000